

***Working Instructions for
Seasonal Adjustment with Demetra¹***



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Contents

Introduction	3
1. Preparations for Seasonal Adjustment	5
1.1 Analysis of the Raw Data	5
1.2 Graphical Inspection and Seasonality	5
1.3 Presence of Calendar Effects	7
1.4 Prepare an Excel File with the Raw Data	7
1.5 Install or Open Demetra	9
2. Seasonal Adjustment	9
2.1 Create a Demetra Project	9
2.2 Import Data	10
2.3 Define Output	11
2.4 Set Rules for Quality Checks	12
2.5 Define Modelling Settings	13
3. Analysis of the Results	16
3.1 Graphical Analysis of the Results	16
3.2 Check Models Used	17
3.3 Analyse the Quality Diagnostics	21
3.4 Output to Excel Files	23
3.5 Documentation	24
4. Further Work on Seasonal Adjustment	24
References	25

Introduction

This paper provides working instructions for performing seasonal adjustment with Demetra software. The purpose of these instructions is to support the introduction of seasonal adjustment procedures. These instructions do not provide theoretical background or argumentation for alternative seasonal adjustment methods. Many existing international handbooks, recommendations, and guidelines provide a good basis for this paper, but the *European Statistical System Guidelines on Seasonal Adjustment* and the *Demetra 2.0 User Manual* are taken as the main references.

Demetra is a seasonal adjustment software provided by Eurostat free of charge on the Internet. It provides a tool for using and comparing the two seasonal adjustment methods, X-12-ARIMA (autoregressive integrated moving average) and TRAMO/SEATS. Demetra has been developed to improve the user friendliness of seasonal adjustment software, and it can read data from many types of files, e.g. Excel. The Automated Module of Demetra is designed to guide the user through the seasonal adjustment process, and to make it more efficient to seasonally adjust a large number of time series. The Detailed Analysis Module, on the other hand, allows in-depth comparisons of different seasonal adjustment settings for a single time series at a time.

Seasonality can be seen as a pattern of a time series, which repeats at regular intervals every year. Raw data is affected by seasonal effects, and may conceal the true underlying economic development of a time series. Thus, the purpose of seasonal adjustment is to simplify the data so that the time series may be more easily interpreted without a significant loss of information. When the seasonal movements have been eliminated, the comparison of data between two different months or quarters becomes possible. The seasonally adjusted data also allow the comparison of different series with different seasonal patterns, i.e. international comparison of economic development.

Seasonal adjustment cannot be replaced by calculating the change of the original data from the same period of the previous year, since this does not remove all seasonal effects. Moving holidays may interrupt with the year-on-year changes: if Easter falls in March (instead of April), the level of activity can change greatly. The year-on-year changes ignore trading day effects and contain the influence of the irregular component. In addition, there are time delays in identification of turning points from the raw data. If we compare to a period of a year ago, we may miss the most recent turning points. For example, if November 2008 had a higher original estimate than November 2007, the series might have increased until May 2008 and then started to decrease. The seasonally adjusted data offer a possibility to calculate change from the previous period, as a result providing a faster and easier detection of the economic cycle.

This paper divides the seasonal adjustment process into three modules: preparations for seasonal adjustment, seasonal adjustment, and analysis of the results. The following chart proposes a process for seasonal adjustment (see chart 1). The working instructions given in this paper are written according to the chart.

Chart 1 Seasonal adjustment with Demetra step-by-step

1.1 Analysis of Raw data	Assess the accuracy and overall quality Note presence of strange values, correct errors Note the length of time series, maintain a long series Assess the quality of production methods, consistency of time series
↓	
1.2 Graphical Inspection and Seasonality	Identify outliers and missing values Note volatility and decomposition Assess the presence of seasonality Look for possible breaks in the seasonality or trend
↓	
1.3 Presence of Calendar Effects	Collect and document the national holidays Demetra checks later which calendar effects apply
↓	
1.4 Prepare an Excel File with Raw Data	Prepare either horizontal or vertical file
↓	
1.5 Install or Open Demetra	Download and install software Open Demetra
↓	
2.1 Create a Demetra Project	Select Project/New Select Automated module (or detailed analysis module)
↓	
2.2 Import Data	Click on the button Excel to select file to be imported Select time span
↓	
2.3 Define Output	Select the components of time series to be saved Select Quality Diagnostics Use the same file for saving or specify another file
↓	
2.4 Set Rules for Quality Checks	Use first the suggested checks and significance levels
↓	
2.5 Define modelling Settings	Choose new automatic modelling, previous or customized settings Choose either TRAMO/SEATS or X-12-ARIMA method Define time span for modelling Choose 7 regressors, but allow reducing the number of regressors Define and save national holidays, add irregular holidays by date Adjust time series
↓	
3.1 Graphical Analysis of the Results	Choose series to be graphed Analyze visually the behaviour of series
↓	
3.2 Check Models Used	Check if 'Model passes all diagnostic tests' Check the results from 'Information on Models' window
↓	
3.3 Analyze Quality Diagnostics	Check the results from 'Information on Diagnostics' window Take note of values exceeding the default limits Interpret the critical test results and document your conclusions
↓	
3.4 Output to Excel Files	Demetra saves the results to the original Excel if other not chosen See the Excel sheets for different result series Compare raw and seasonally adjusted data, different time series
↓	
3.5 Documentation	Document the used models and results of diagnostics Archive the resulting time series for later revision analysis Prepare metadata to be published to the users of statistics

1. Preparations for Seasonal Adjustment

1.1 Analysis of Raw Data

The quality of seasonal adjustment depends on the quality of the raw data. It is therefore necessary first to analyse the original data: to consider the accuracy, length of time series, quality of production methods and consistency of time series. Any weaknesses should be documented so that the users of statistics can be informed.

For seasonal adjustment, the time series has to be at least 3 years long (36 observations) for monthly series, and 4 years long (16 observations) for quarterly series. For an adequate seasonal adjustment, more than five years of data are recommended. Instability of seasonally adjusted data could arise for series less than 10 years long.

With longer time series, consistency over time needs to be ensured. This means that the effects of changes in concepts, definitions and methodology need to be corrected for. The entire time series should be recalculated in case of changes in the applied methods or classifications.

Seasonal adjustment cannot be performed on cumulative indices. Cumulative indices are a measure of summarizing the development during the current year compared to the corresponding period of the previous year (e.g. January to May). Thus, the length of the reference period changes with each publication of data. As a result, the user of statistics cannot derive a correct monthly or quarterly time series from the cumulative indices. This is because revisions cannot be matched to the correct periods of time. Therefore, it is recommended to maintain the entire revised monthly or quarterly time series, and to provide it in each publication.

In general, the production methods should be based on widely recommended practices, and on internationally comparable definitions and classifications. The raw data need to be revised with new data, and any errors should be detected and corrected. The users of statistics are to be informed about any possible quality issues associated with the data.

1.2 Graphical Inspection and Seasonality

Before starting with seasonal adjustment, it is important to analyse the graphs of the original time series. This is done to identify the possible outliers, missing values, volatility, decomposition, presence of seasonality and breaks in the seasonality or trend of the time series.

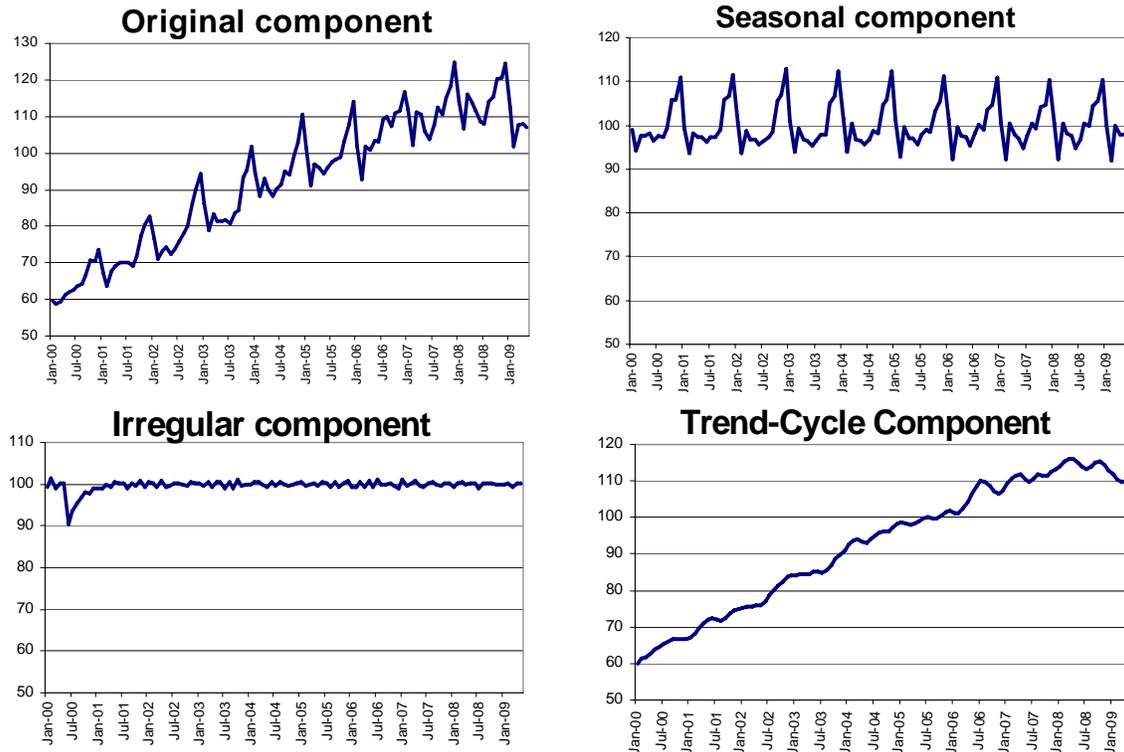
Sometimes the presence of strange values, e.g. outliers, complicates seasonal adjustment and affects its quality. The series with possible outlier values should be identified, and records about specific events causing outliers should be kept. The outliers need to be verified as valid and not as an error in the data. In case of errors, the raw data should be corrected and recalculated before achievement of seasonal adjustment. If an outlier is caused by a real occurrence, it should remain visible in the seasonally adjusted series. Series with too many outliers (i.e. if more than 10% of observations are irregular) will cause estimation problems.

Missing observations in a time series should be identified and explained. Series with too many missing values will cause estimation problems. There should not be any missing

observations unless no activity was recorded in the target population. Instead, the missing values should ideally be corrected with alternative data sources or estimated before achieving seasonal adjustment.

In order to separate noise and seasonal effects from economic development, it is natural to try to decompose a time series. It is easy to recognize different components of time series from the graphical presentation (see the following graph). The trend series should be smooth, evolving over the long term without much disturbance. Seasonality should be periodical; it should occur in almost the same way from one year to the next. The irregular component is a residual, but essential in validating the model. In other words, the irregular component must not contain information or it would invalidate the quality of the other components. However, the irregular components may contain information about some historical events, such as outliers caused by strikes and changes in calculation methodology, etc.

Graph 1
Components of Time Series, Industrial Production Index of Kazakhstan



The presence of seasonality and breaks in the seasonal behaviour of a time series can be detected visually. You can compare the magnitude of seasonal variations to the variations of the irregular component. If the seasonal component is lost in the noise of the irregular component, the seasonality may be considered insignificant. If the series does not indicate the presence of seasonality, it is either not seasonal or its seasonality is not consistent enough for adjustment. Different autocorrelation functions can be used to find the repeating patterns caused by seasonality. These tests, such as the Ljung-Box or Box-Pierce test on residuals, are also applied to verify that there is no remaining seasonality after seasonal adjustment has been performed.

The decomposition model of a time series is defined in order to select a sufficient seasonal adjustment model for the time series. Demetra provides a procedure for testing it, and applies the correct decomposition model automatically. The model can also be identified with graphical inspection of the time series. If the magnitude of the variations of the series does not change as the level of the trend changes, the series is formed additively as a sum of its components. The additive decomposition will also apply for a series with zero or negative values. On the other hand, the decomposition model is multiplicative if the volatility of the time series changes when the trend grows or declines (see chapter 3.2.). However, the two models are indistinguishable from one another if the level of the series remains constant throughout the period, i.e. the decomposition model is unidentifiable.

1.3 Presence of Calendar Effects

Before seasonal adjustment, it is important to analyse which calendar effects may affect the time series. Based on this, the decision on which regressors to apply can be reached. The availability and use of national calendars improves remarkably the quality of adjustment.

By definition, a regressor is a variable that is used to explain another variable. When preparing for seasonal adjustment, you need to decide which regressors to apply. Economic time series are usually affected by calendar effects. The varying length of the months, the number of different days appearing during the month and moving holidays affect the results of statistics. Demetra tests for these different effects and applies the regressors only if the effects are judged significant:

- trading or working days,
- leap year,
- moving holidays (e.g. Easter or Ramadan) and
- national holidays.

Demetra provides some national calendars, but for many countries the information about the annual national holidays should be collected before seasonal adjustment. It is better to use official sources for the holidays when possible. The national calendars used should also be documented as a part of the metadata on seasonal adjustment.

Demetra tests for the significance of different calendar effects. If the calendar effects are not plausible for the series or not significant, the regressors for such effects should not be applied. Demetra provides five alternatives to correct for the different calendar effects. If the series is long and the calendar effects highly significant, a greater amount of regressors for the calendar effects should be applied. Demetra offers automatic options for the selection of regressors, and applies the regressors if the estimated effects are judged significant.

1.4 Prepare an Excel File with Raw Data

Define the data to be seasonally adjusted and extract the data to an Excel file. The Excel file has to meet certain criteria to be a suitable input for Demetra. One sheet per file is used for the input. The set of time series can be arranged either vertically (by columns) or horizontally (by rows). Further instructions about using other types of files can be found in the Demetra 2.0 User Manual.

To prepare the Excel file with either horizontal or vertical time series data, see the corresponding instructions. If there are missing data in the middle of a time series, you can either leave the cells empty, or you can use "-99999.0", "." or "#N/A". These values are automatically treated as missing values by Demetra.

A. Horizontal Time Series File

Type "**Horizontal**" into the cell "A1" in an Excel file. Type the **start date** of the time series in the cell "B1", e.g. 01/2000 for January 2000. These cells must be date formatted, i.e. 01/2000 is displayed as "Jan-00". The names of each series are mentioned in the column "A", starting from the second row (see the next window). Up to 65535 (16383 if an Excel version < 8.0) series with a maximum length of 254 observations can be treated.

	A	B	C	D	E	F	G	H	I	J	D1	D2	EA	EB	EC
1	HORIZONTAL	Jan-85	Feb-85	Mar-85	Apr-85	May-85	Jun-85	Jul-85	Aug-85	Sep-	Aug-95	Sep-95	Oct-95	Nov-95	Dec-95
2	Serienname1	71.3	77	81.7	72.7	82.9	86.9	-99999	-99999	#N/A	99.4	115.3	113.6	119	121.4
3	Serienname2				97.9	101.5	101.5	101.5	100.3	91.1	89.6	91.5			
4															

B. Vertical Time Series File

Type "**Vertical**" into the cell "A1" in an Excel file. Type the **start date** of the series in the cell "A2". These cells must be date formatted. The names of each series are mentioned in the first row, starting from the second column (see the next window). A maximum of 255 time series with a length of 600 observations can be treated.

	A	B	C	D
1	VERTICAL	Serienname1	Serienname2	
2		Jan-85	71.3	
3		Feb-85	77	
4		Mar-85	81.7	
5		Apr-85	72.7	97.9
6		May-85	82.9	101.5
7		Jun-85	86.9	101.5
8		Jul-85	-99999	101.5
9		Aug-85	-99999	100.3
10		Sep-85	#N/A	91.1
11		Oct-85		89.9
12		Nov-85		104.5
13		Dec-85	88.9	104.6
14		Jan-86	74.6	104.9
15		Feb-86	80	113.7
128		Aug-95	109.4	86.3
129		Aug-95	99.4	89.6
130		Sep-95	115.3	91.5
131		Oct-95	113.6	
132		Nov-95	119	
133		Dec-95	121.4	

The advanced users may write their chosen parameters directly to the Excel file after the end of the time series. The parameters refer to arguments or values that are passed to Demetra software to guide the seasonal adjustment process. It is not recommended to write parameters directly to the Excel file if you are not completely sure of their meanings. Instead, use preferably the set of parameters defined in the actual seasonal adjustment process in Demetra.

1.5 Install or Open Demetra

The *Demetra User Manual* and *Demetra Pedagogical Manual* contain essential instructions for the use of the software. For installation of Demetra software go to: <http://circa.europa.eu/irc/dsis/eurosam/info/data/demetra.htm>

Please read the legal notice while installing the software, and note that Eurostat gives no warranty for the use of the software. Demetra provides two seasonal adjustment methods:

- TRAMO/SEATS, which is an ARIMA model-based method, written by V. Gómez and A. Maravall, and
- X-12-ARIMA of the US Census Bureau.

Select **download** and you are redirected to Eurostat's circa site. Select *Demetra 2.2* or the most recent version. **Save the zipped file** to your computer. **Unzip** the installation file from your computer. Take note of the folder where Demetra is saved and open the program file: **Demetra.exe**. It will guide you through the **installation**.

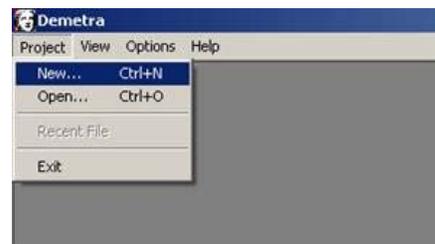
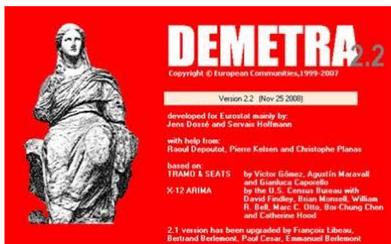
Open Demetra software to start seasonal adjustment.

2. Seasonal Adjustment

2.1 Create a Demetra Project

To start the process of seasonal adjustment, a new Demetra project is created. For this you need to select either the automatic module or the detailed analysis module for the whole capacity of analysis.

Select **Project/New** if you want to input new original data for seasonal adjustment (see the next window).



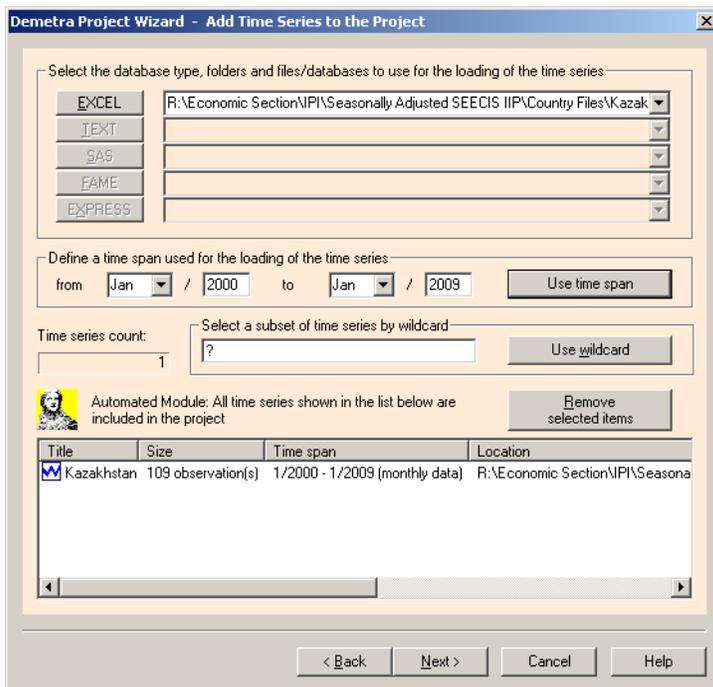
Choose the **automated module** if you want to treat many time series at once, or if you want to make the first adjustments to your time series. For a single time series and the whole capacity of parameters, you can also use the **detailed analysis module** (see the next window).



2.2 Import Data

Demetra provides an easy process to import data from several types of files. These instructions provide guidance for importing data from an Excel file.

Click on the button **Excel** to import the file which was previously created and prepared. **Select the file** from the folder. Click on **Open**. The time series data should appear on the window. Select **time span**: Choose the first month of time series and type in the first year, choose the last month of time series and type in the last year. Click on **Use time span**. Click on **next** (see the next window).



2.3 Define Output

During this phase you can select the components of time series and the quality checks to be saved. For the storage of data it is practical to use the same file, which contains the raw data to be seasonally adjusted.

Select at least the final trend and the final seasonally adjusted series to be saved. It is advisable to also save the seasonal and the irregular components. Click on **Quality Diagnostics** to select them to be stored (see the next window).

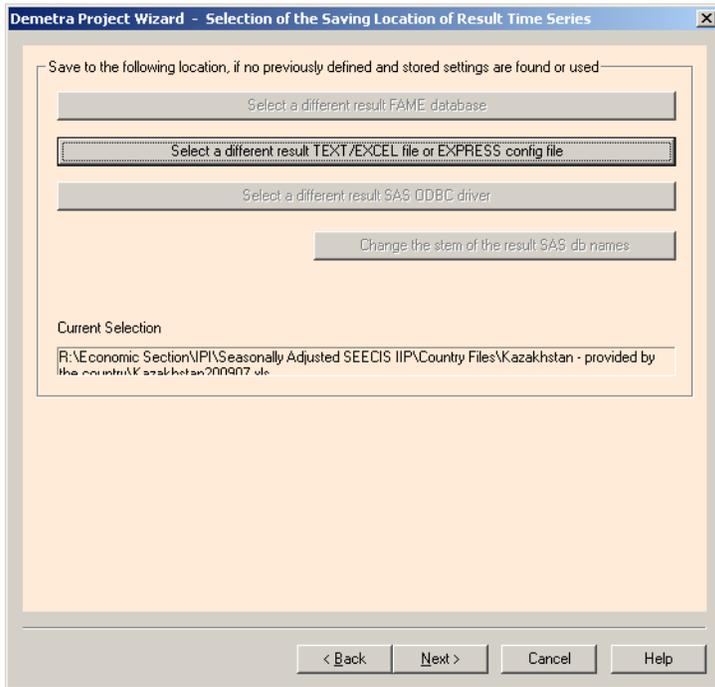
The screenshot shows the 'Demetra Project Wizard - Selection of the Types of Result Time Series' dialog box. It is divided into several sections for selecting components to save:

- Save the Following Types of Result Time Series:**
 - Final Components:** Final Trend, Final Seasonally Adjusted Series.
 - Other Final Components:** Three dropdown menus with 'Final Seasonal Factors/Component', 'Final Irregular Factors/Component', and 'Final Transitory Factors/Component' selected.
 - Preliminary Result Series:** Three dropdown menus with 'Linearity series', 'Residuals', and 'Interp. Series Corr. for Calendar Effects' selected.
 - Pre-adjustment Factors/Components:** Three dropdown menus with 'Aggregate Pre-Adjustment Factors/Component', 'Aggregate Outlier Effects', and 'Transitory Change Outliers' selected.
 - Forecasts of Final Components:** Forecast of Final Trend, Forecast of Final Seasonally Adjusted Series.
 - Other Forecasts of Final Components:** Three dropdown menus with 'Forecasted Final Seasonal Factors/Component', 'Forecasted Final Irregular Factors/Component', and 'Forecasted Final Transitory Factors/Component' selected.
 - Forecasts of Preliminary Result Series:** Three dropdown menus with 'Forecasted Seasonally Adjusted Series', 'Forecasted Trend', and 'Forecasted Seasonal Factors/Component' selected.
 - Forecasts of Pre-adjustment Factors/Components:** Three dropdown menus with 'Forecasted Aggregate Pre-Adj. Factors/Comp', 'Forecasted Aggregate Outlier Effects', and 'Forecasted Transitory Change Outliers' selected.
- Do not save factors as percentages (only Tramo/Seats) [Quality Diagnostics]
- User-specified Names (Suffix) for Result Time Series:**
 - Type of Result Time Series: 'Final Seasonally Adjusted Series' (dropdown)
 - Save Result Time Series as (use wildcards): '.fa' (text box)
 - Name of the result series for the 1st original series: 'Armenia.fa' (text box)

At the bottom, there are buttons for '< Back', 'Next >', 'Cancel', and 'Help'.

At the bottom of the window, you can customize the suffixes of the names for the resulting time series. These names correspond to the names of the sheets in the Excel file. Renaming the series may make it easier to read the results, but take note of the new names. If you choose to use the default names, the abbreviations are listed in the *Demetra User Manual*. Click on **next**.

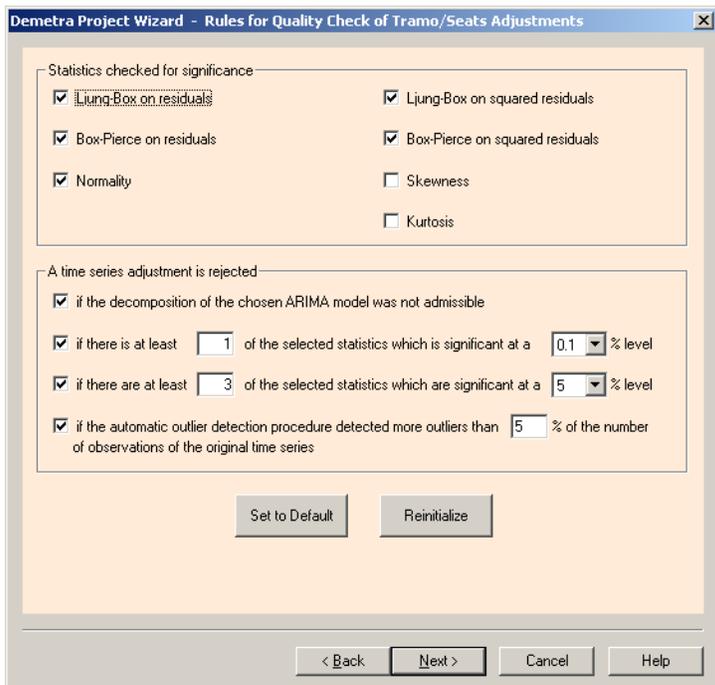
Demetra will save the results in the same file if you do not specify another filename by selecting "Select a different result TEXT/EXCEL file or EXPRESS config file". You do not need to define a different file since it is convenient to use the same file. The raw data will not be overwritten. If you choose to use the same file, just click on **next** again (see the next window).

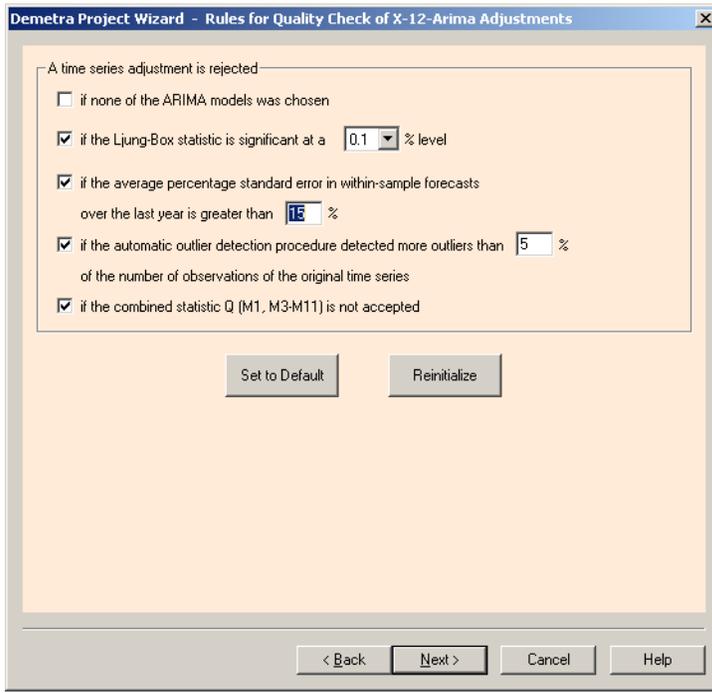


2.4 Set Rules for Quality Checks

Demetra provides a set of default quality checks to ensure the quality of seasonal adjustment. It is recommended to use these tests at the default significance levels.

You can use the suggested quality checks and significance levels. The more experienced users may also decide to specify the significance levels of test statistics in the lower part of the window (see the next two windows).





2.5 Define Modelling Settings

Demetra provides three alternative modelling tools for seasonal adjustment, depending on the purpose of the adjustment. You will also choose which seasonal adjustment method to use, TRAMO/SEATS or X-12-ARIMA. During this phase, the time span and regressors for calendar adjustment are chosen. It is advisable to add the national calendar before seasonally adjusting the time series.

Demetra offers three tools for seasonal adjustment. You can choose:

- **new automatic modelling** to perform the first seasonal adjustment on the time series or to perform yearly re-identification of models and parameters;
- **previous modelling settings** for a second adjustment of the time series or for a regular monthly or quarterly adjustment;
- **new customized modelling** if you want to modify the modelling settings and study some of the time series in more detail (see the next window).

A. Use of the New Automatic Processing

If you choose the **new automatic processing**, it will ignore all previous modelling settings and readjust all the time series by a set of default automatic parameters. This will replace any previous parameters if they exist. For the first seasonal adjustment or yearly re-identification, choose: “Save updated parameter for each original time series to the database”. Click on **next**. The parameters of the new adjustment are stored in the file of the raw data.

Demetra defines a complete set of default parameters for the new automatic processing:

- pre-tests for a logarithm transformation (multiplicative/additive modelling);
- a mean correction (if necessary);
- a new ARIMA model identification/selection and estimation;
- pre-tests for Easter and one of five trading day effects (country-specific holidays);
- an automatic detection and correction for outliers for the entire time series;
- an interpolation of missing observations;

- an ARIMA forecast at the end of the series; and
- an automatic decomposition.

B. Use of the Previously Defined Settings

This module is provided since the choice of the seasonal adjustment model or the re-estimation of its parameters is generally not made for each publication, but typically about once a year. By default, use of the previous modelling settings results in not saving the parameters. To use the previous modelling settings, you can choose either to:

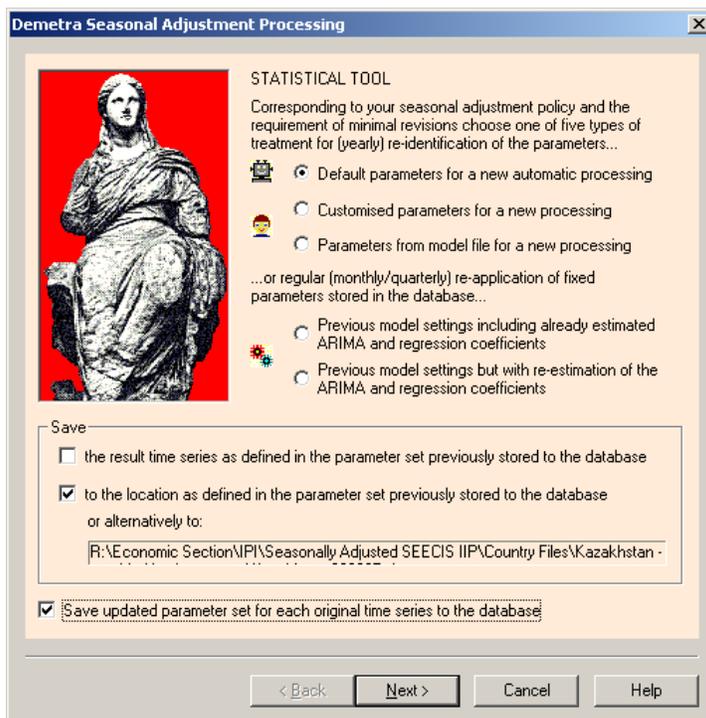
- use the same modelling settings with re-estimation; or
- use the same modelling settings including the already estimated ARIMA and regression coefficients (see the next window).

If you decide to use the first option, previously set modelling with re-estimation of ARIMA and regression coefficients, Demetra re-estimates the coefficients for ARIMA and regression models, but does not re-estimate the seasonal adjustment models. This is the difference compared to the new automatic processing. In this option with previous settings, Demetra also re-estimates the outliers, coefficient of the mean and corrections for the trading day and Easter effects.

In the latter case, previously defined modelling with the already estimated coefficients, Demetra performs seasonal adjustment with fixed options, and performs estimation of the new observations with the given modelling settings.

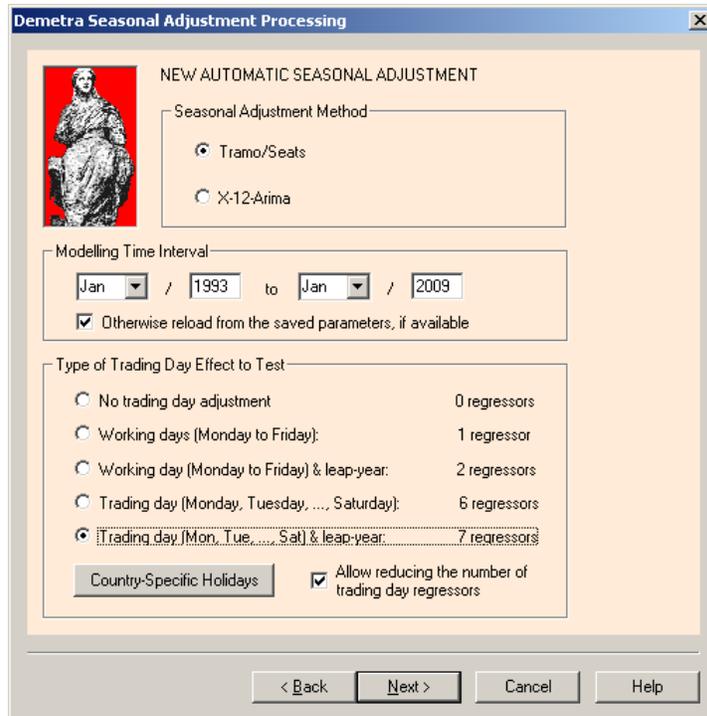
C. Use of the New Customized Modelling

The *Demetra User Manual* provides further instructions to work with the new customized modelling. This module can be used to carry out a study on a series to which you can devote more time or to modify the options for some time series.



Choose one of the seasonal adjustment methods, TRAMO/SEATS or X-12-ARIMA (see the next window). Both methods are recommended; one method is not necessarily

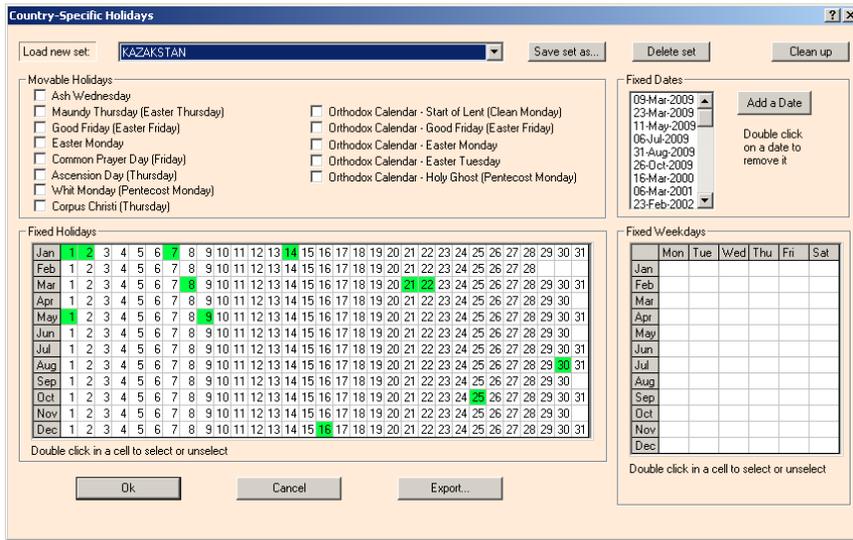
better than the other. TRAMO/SEATS uses seasonal adjustment filters based on statistical decisions, whereas the X-12-ARIMA uses moving averages. TRAMO in general possesses more flexible pre-adjustment options for an automatic running in Demetra. At the moment, TRAMO/SEATS is the most commonly used seasonal adjustment method in Europe. Consequently, these working instructions are written based on the choice of TRAMO/SEATS. Detailed instructions for the use of X-12-ARIMA can be found in the *Demetra Manuals*.



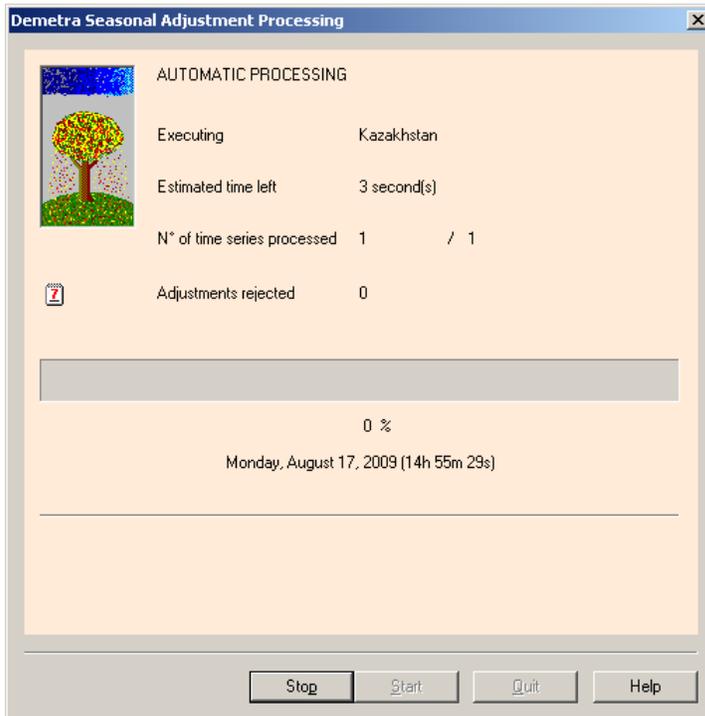
To **specify the time span for modelling** seasonality of a time series, type in the dates from the first month and year to the last month and year. In case of a break in seasonality, you can also try to limit the time span for identifying seasonality.

A short time series should rather be adjusted with a few trading day variables (1 or 2), whereas a longer one may be better adjusted with 6 or 7 regressors. With the most important aggregate time series, you should try many alternatives and decide which is the best one by using the number of rejected adjustments or the quality of the diagnostic statistics. However, you can leave the choice to Demetra if you are uncertain. It is practical to choose **7 regressors**, but **allow Demetra to reduce the number of trading day regressors**.

Before proceeding, the **country-specific holidays** need be defined (see the next window). Demetra provides calendars for some countries, for others information about annual holidays should be collected before seasonal adjustment. For regular annual holidays, double-click on the appropriate dates. Irregular holidays should be added by selecting the specific dates for a specific year by clicking on **add a date**. The date specifications can be saved for further use by clicking on **save set as...**-button. Click on **ok**.



Click on **next**. Then choose **adjust time series now** and click on **start** to perform seasonal adjustment (see the next window).

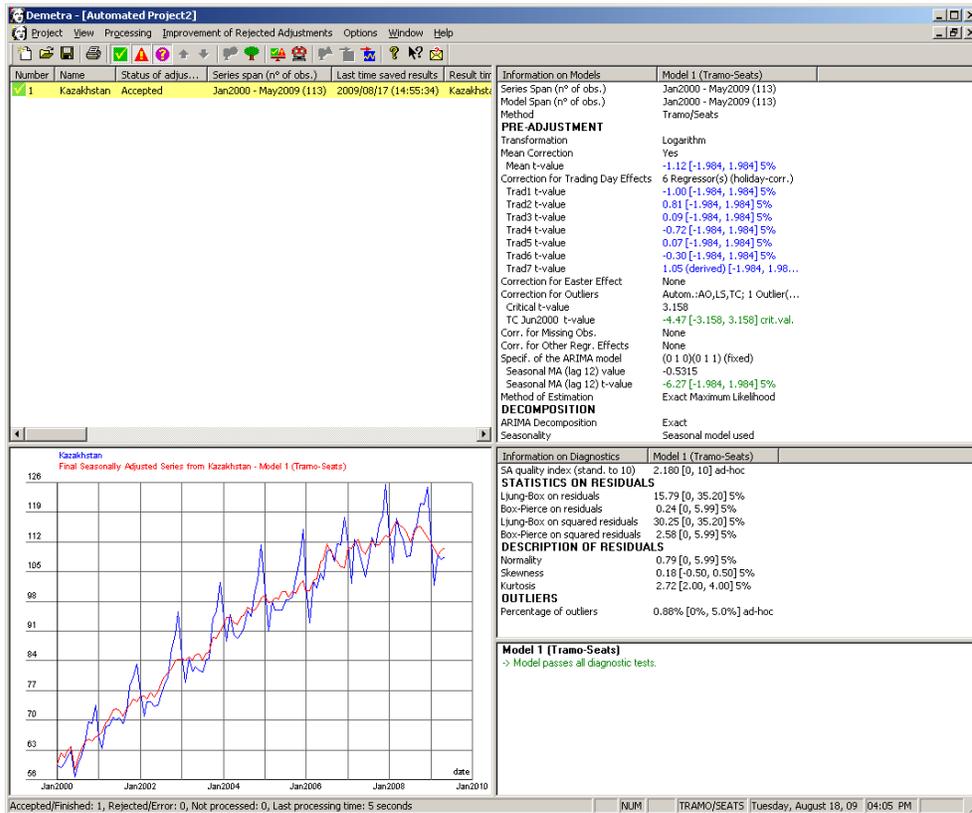


3. Analysis of the Results

3.1 Graphical Analysis of the Results

The first quality assessments can be made by looking at the graph.

Looking at the graphs is a rapid way to go through the series (see chapter 1.2). By right-clicking the mouse on top of the graph, you can choose which series to be graphed. If some of the series do not appear, the adjustment may have been rejected. *The Demetra Pedagogical Manual* provides advice with improvement of rejected series.



3.2 Check Models Used

The last message on the right side of the results window summarizes the quality of the seasonal adjustment, e.g. “Model passes all diagnostic tests”. The “Information on Models” window is important for the documentation of the seasonal adjustment process. The window contains information on the length of time series, model span and method of adjustment.

Information on Models	Model 1 (Tramo-Seats)
Series Span (n° of obs.)	Jan2000 - May2009 (113)
Model Span (n° of obs.)	Jan2000 - May2009 (113)
Method	Tramo/Seats
PRE-ADJUSTMENT	
Transformation	Logarithm
Mean Correction	Yes
Mean t-value	-1.12 [-1.984, 1.984] 5%
Correction for Trading Day Effects	6 Regressor(s) (holiday-corr.)
Trad1 t-value	-1.00 [-1.984, 1.984] 5%
Trad2 t-value	0.81 [-1.984, 1.984] 5%
Trad3 t-value	0.09 [-1.984, 1.984] 5%
Trad4 t-value	-0.72 [-1.984, 1.984] 5%
Trad5 t-value	0.07 [-1.984, 1.984] 5%
Trad6 t-value	-0.30 [-1.984, 1.984] 5%
Trad7 t-value	1.05 (derived) [-1.984, 1.984] 5%
Correction for Easter Effect	None
Correction for Outliers	Autom.:AO,LS,TC; 1 Outlier(...)
Critical t-value	3.158
TC Jun2000 t-value	-4.47 [-3.158, 3.158] crit.val.
Corr. for Missing Obs.	None
Corr. for Other Regr. Effects	None
Specif. of the ARIMA model	(0 1 0)(0 1 1) (fixed)
Seasonal MA (lag 12) value	-0.5315
Seasonal MA (lag 12) t-value	-6.27 [-1.984, 1.984] 5%
Method of Estimation	Exact Maximum Likelihood
DECOMPOSITION	
ARIMA Decomposition	Exact
Seasonality	Seasonal model used

The window “Information on Models” is divided into headings. The heading ‘**pre-adjustment**’ shows the means of pre-adjustment: the type of transformation, mean correction, corrections for trading day effects, outliers, missing observations or other regression effects. The method of estimation is also documented here.

Under the heading ‘**decomposition**’ of the “Information on Models” window, you will find the applied decomposition model, and whether a seasonal model was applied.

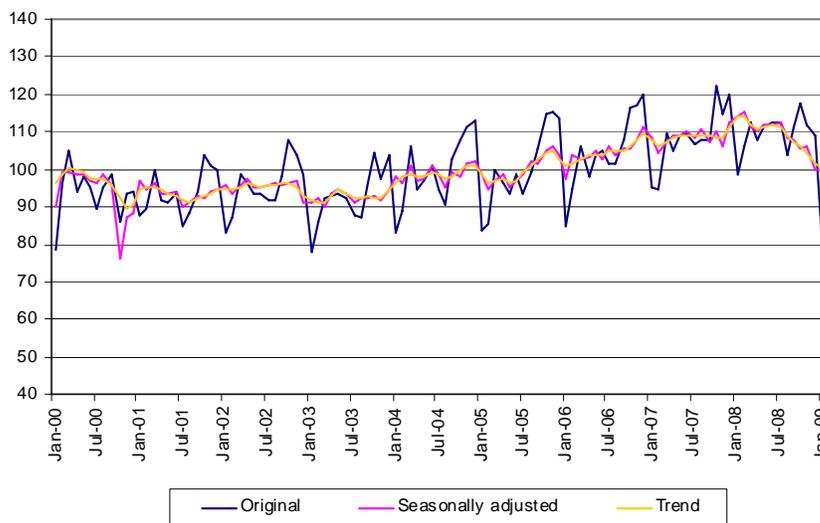
Pre-tests for a Decomposition Model

Demetra provides an automatic procedure for testing whether multiplicative or additive modelling should be used; it is recommended to use the automatic test. Seasonal adjustment is based on the idea that an original time series can be decomposed into three components: trend, seasonal and irregular. The features of the time series define which decomposition model, either multiplicative or additive, to use.

The additive decomposition assumes that the components of the series behave independently of each other (see graph 2). This kind of time series can be identified by analyzing the graph: the magnitude of seasonal or irregular variations does not change as does the level of trend. For the series with zero or negative values, the additive decomposition is automatically selected. Additive decomposition means that the time series is constructed as a sum of the independent components: seasonal + trend + irregular.

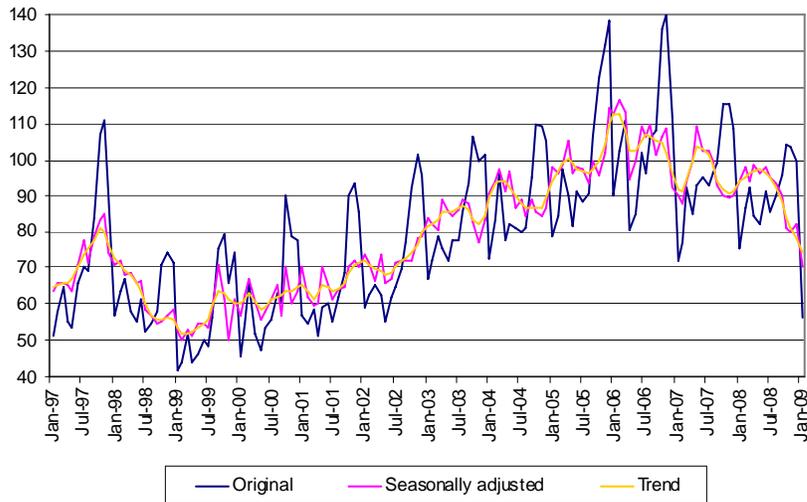
Graph 2

An example of the additive decomposition, Industrial Production Index in Serbia.



The multiplicative decomposition can also be identified by the features of the time series: as the trend of the series increases, the magnitude of the seasonal spikes also increases (see graph 3). The original time series is expressed as the product of the components: seasonal x trend x irregular. Most of the series show the characteristics of a multiplicative decomposition. If the series has a decreasing level, with positive values close to zero and no negative values, the multiplicative adjustment should be used.

Graph 3
An example of the multiplicative decomposition, Industrial Production Index in Moldova.



Mean Correction

The residuals of the ARIMA model are supposed to follow a normal distribution that includes a mean of zero. Hence, a preceding mean correction may be necessary.

Pre-tests for Trading Day Effects

The economic activities may be strongly influenced by some calendar effects like the varying number of working or non-working days, differences in the economic activity of different weekdays, differences in the length of the month, and changes caused by moving holidays. In order to improve the seasonal modelling, such effects should be eliminated before the decomposition. The possible five different trading day options are:

- No trading day effect;
- Working day effect: there are no differences in the economic activity between the working days (Monday to Friday) but between these and non-working days (Saturday, Sunday). Hence, the varying number of these days is considered;
- Working day and length-of-period effect: as before, the varying number of working and non-working days is considered, together with the total number of days per period;
- Trading day effect: there are differences in the economic activity between all days of the week. Hence, the varying number of these days is considered;
- Trading day and length-of-period effect: as before, the varying number of all days is considered, together with the total number of days per period.

As well as the trading day and working day effects, the effects of moving holidays should also be adjusted in the seasonal adjustment process. From the “Information on Models” window, you can see the amount of regressors used for trading day effects.

Pre-tests for Easter

The varying number of Easter days that fall in either March or April may affect the economic activities. The number of the Easter affected days per year may be adapted to the type of time series if the user possesses more detailed information on the economic background. However, a default value derived from many practical experiences is suggested by the Demetra software.

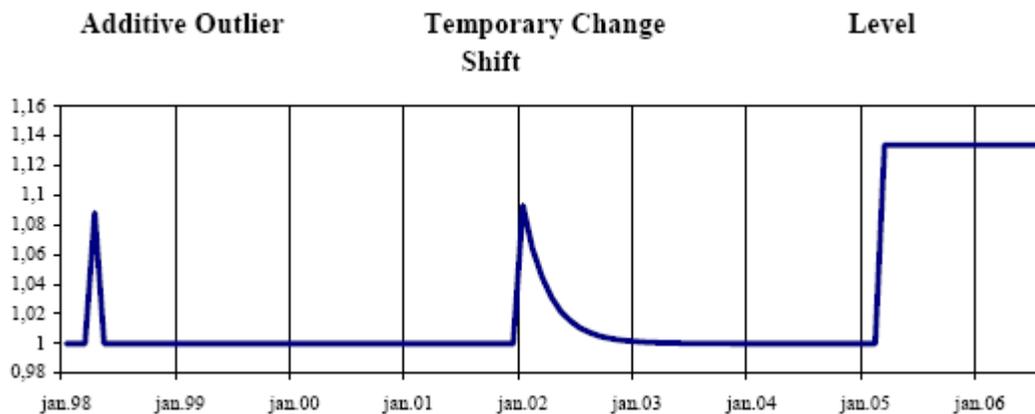
Outlier Detection and Correction

Outliers, abnormal values, should be detected and replaced before estimating the seasonal and calendar components. This is automatically done by Demetra. Since the outliers give information about specific events (like strikes), they should remain visible in the seasonally adjusted data.

Demetra has built-in procedures to detect and correct the various kinds of outliers: impulse outliers, transitory changes and level shifts. An additive or impulse outlier can be recognized as a single point jump in the time series, a temporary change is a single point jump followed by a smooth return to the original path, and a level shift a more permanent change in the level of the series (see the next graph). Unfortunately, real extraordinary economic effects are often unknown, and the values are sometimes detected only because they fall out of the expected structure modeled by ARIMA. You can switch the automatic outlier detection and correction on or off.

Graph 4

The most common types of outliers



A critical value determines how extreme an observation must be before it will be considered an outlier. In Demetra, the value varies from 2.8 (high sensitivity) to 4.1 (low sensitivity). The automatic value is determined by the length of each time series: the shorter the series, the lower the critical value. The critical value may be chosen to be smaller or larger, but this kind of judgement requires experience. The ARIMA methods are sensitive to disturbances, breaks or outliers in the time series. Therefore, it is important to choose a sensitive detection mechanism in order to guarantee the quality of the model selected. This is why the pre-adjustments are more detailed in TRAMO/SEATS than in X-12-ARIMA.

Interpolation of Missing Observations

In X-12-ARIMA, a missing value in the original series is replaced with an additive outlier, large enough to be considered an outlier during the model estimation. After the

regARIMA model is estimated, the missing values will be replaced with the adjusted values. TRAMO/SEATS can be set to treat the missing values as additional outliers, or to disregard the missing values.

ARIMA Model Identification, Selection and Estimation

TRAMO will try to identify the most suitable seasonal ARIMA model and will estimate the corresponding model parameters for each time series in an automated way. X-12-ARIMA automatically selects the seasonal model from a given limited list (the default list includes 5 models). SEATS has a fixed internal list, which cannot be changed.

You can change the modelling time span for TRAMO/SEATS and X-12-ARIMA. Note that only the model identification and estimation are limited to that span. The series will be adjusted over its full time span using the fixed modelling settings.

ARIMA Forecast at the End of the Series

An ARIMA model is identified (TRAMO/SEATS) or selected from a list of default models (X-12-ARIMA). To generate the forecast for the end of the time series, the models are estimated for each time series. Alternatively, no identification is undertaken, the airline model is simply estimated. The airline model is one of the most commonly used seasonal models. It was introduced by Box and Jenkins (1976), who used it to study a time series of the number of airline passengers. The airline model falls within the class of seasonal ARIMA models. The model is quite commonly applied, but one can expect better results using more specific models adapted to each of the time series.

Automatic Decomposition

The seasonal and trend moving averages ("filters") used in estimation of the seasonal and trend components can be controlled. The user can choose between the 3x3, 3x5 and 3x9 seasonal filters or the automatic option. The automatic option computes a ratio of the preliminary estimates of the irregular and the seasonal component. Roughly, large values point to a relatively stable seasonality and suggest the use of a long seasonal moving average; on the contrary, small ratios indicate a relatively unstable seasonality leading to the use of short seasonal moving filters.

Two types of decomposition can be performed:

- Normal decomposition into trend, seasonal and irregular component;
- Reduced decomposition without seasonal adjustment: only the trend is computed.

3.3 Analyse the Quality Diagnostics

Demetra supplies many indicators for the validation of seasonal adjustment and detects any unsatisfying results. In addition, a user can select the significance levels and the number of outliers to be accepted among the diagnostic statistics, but this requires experience with the method. It is useful to conduct experiments with different kinds of quality diagnostics.

After fitting the model, it should be verified that the chosen model is appropriate. The primary tool for model diagnostic checking is residual analysis. The autocorrelation function is used for finding repeating patterns in a time series, i.e. to define the presence of seasonality in a time series. Once the series is adjusted for seasonality, there should be no remaining seasonal effect in the adjusted series; it should not show significant or positive autocorrelation. Similarly, the irregular component should not include any

outstanding information. As a default, Demetra provides Ljung-Box and Box-Pierce statistics on residuals and squared residuals (see the next window).

Demetra also offers statistics on the distribution of residuals (normality, skewness and kurtosis). The values of these statistics are high when the distribution of residuals deviates from the ideal distribution. By exploring these measurements, you can identify the presence of disturbances, breaks or structural changes.

Information on Diagnostics	Model 1 (Tramo-Seats)
SA quality index (stand. to 10)	2.180 [0, 10] ad-hoc
STATISTICS ON RESIDUALS	
Ljung-Box on residuals	15.79 [0, 35.20] 5%
Box-Pierce on residuals	0.24 [0, 5.99] 5%
Ljung-Box on squared residuals	30.25 [0, 35.20] 5%
Box-Pierce on squared residuals	2.58 [0, 5.99] 5%
DESCRIPTION OF RESIDUALS	
Normality	0.79 [0, 5.99] 5%
Skewness	0.18 [-0.50, 0.50] 5%
Kurtosis	2.72 [2.00, 4.00] 5%
OUTLIERS	
Percentage of outliers	0.88% [0%, 5.0%] ad-hoc

Seasonal Adjustment Quality Index

The SA quality index is calculated using all of the applied diagnostic statistics. The quality index varies from 0 (the optimal value) to infinity (the worst value). If the value exceeds the standard base value of 10 at least one statistical test must have been significant. The quality index can also be used to compare X-12-ARIMA and TRAMO/SEATS.

Ljung-Box on Residuals

A result outside the confidence interval signifies that there is evidence of autocorrelation in the residuals. This indicates a remaining linear, unwanted structure in the series, i.e. outstanding information instead of only residual noise.

Box-Pierce on Residuals

A result outside the confidence interval signifies that there is evidence of autocorrelation in the residuals. This indicates a remaining linear, unwanted structure in the series, i.e. outstanding information instead of only residual noise.

Ljung-Box on Squared Residuals

A result outside the confidence interval signifies that there is evidence of autocorrelation in the squared residuals. This indicates a remaining non-linear, unwanted seasonal structure in the series, i.e. outstanding information instead of only residual noise.

Box-Pierce on Squared Residuals

A result outside the confidence interval signifies that there is evidence of autocorrelation in the squared residuals. This indicates a remaining non-linear, unwanted seasonal structure in the series, i.e. outstanding information instead of only residual noise.

Normality

A result outside the confidence interval signifies that the distribution of the residuals shows asymmetry and/or kurtosis pattern inconsistent with the normal distribution.

Skewness

A result outside the confidence interval signifies that there is some evidence of skewness in the residuals. This indicates that the residuals are asymmetrically distributed. Skewness is a measure of how symmetrical a distribution is. A symmetrical distribution has a skewness factor of 0.

Kurtosis

A result outside the confidence interval signifies that there is evidence of kurtosis in the residuals. Kurtosis is a statistical measure which is used to describe the distribution of the observed data around the mean. Kurtosis is a measure of how peaked or flat a distribution is. A true normal distribution has a kurtosis factor of 3. A higher value means it is more peaked and a lower value means it is flatter.

Percentage of outliers

A high number of outliers indicates a problem related to weak stability of the process or a problem with the reliability of the data. As a result, the ARIMA model cannot fit all of the observations.

3.4 Output to Excel Files

After the data has been provided to Demetra via an EXCEL file, the outputs will be written to different sheets of the same file, if a different file was not specified. One result sheet is used per type of result time series (one for seasonally adjusted, one for trend, etc). The sheet is named with Demetra_Results_ and the abbreviation of the result series.

See examples of the abbreviations in the table below. *Demetra User Manual* contains the full list of abbreviations.

Final Components

Final Seasonally Adjusted Series	fa
Final Trend	ft
Final Seasonal Factors/Component	fs
Final Irregular Factors/Component	fi

Pre-adjustment Factors (or Components)

Aggregate Pre-Adjustment Factors (Component)	p
Aggregate Outlier Effects	po
Aggregate Trading Day Effects	pt

Preliminary Result Series

Residuals	res
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Forecasted Final Components

Forecasted Final Seasonal Factors (Comp.)	fs_f
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Any last written result data of a series are marked in red in the Excel file (the rest of the result series are set to black). The result time series are only saved if a model was accepted.

The data can be further analysed in the Excel format. In practice, the deviation between the raw and the seasonally adjusted series is often assessed, e.g. by comparing the changes from the corresponding period of the previous year between the two types of series. It is also useful to compare the seasonally adjusted time series between related series or aggregate and disaggregate series.

3.5 Documentation

To ensure the quality of seasonal adjustment, a sufficient amount of documentation is needed. Systematic archiving of the resulting time series and calendars used is important for later revision analysis. Furthermore, it is practical to archive the results window in Demetra for each individual time series (see chapter 3.1). Documentation of these applied models and diagnostics will leave you with precise information for the next adjustment process. These documents are most useful if they are accompanied with a few words of conclusion and interpretation of the quality of the result series in question.

It is recommended to follow the principle of transparency with seasonal adjustment. In short, this means offering enough metadata to enable the users to understand, and even to replicate, the seasonal adjustment. Users expect to know how the adjustment has been performed in order to assess the reliability of data. Adequate documentation provides users and practitioners alike with the facility to properly compare seasonally adjusted series.

To enable repetition of seasonal adjustment, you should offer information on the method and software used, decision rules, outlier detection and correction methods, revision policy, description of trading day adjustment choices, and contacts with the experts. Undoubtedly, there are different users with different needs. A non-technical and easily understandable explanation of seasonal adjustment is also needed for the users of statistics.

Metadata should be attached to each data release and kept regularly updated. A metadata template is annexed to the *ESS guidelines on seasonal adjustment*. Further details on data and metadata presentation recommendations are available in the *OECD Data and Metadata Reporting and Presentation Handbook*.

4. Further Work on Seasonal Adjustment

By experimenting with different options of Demetra, the experience and understanding of seasonal adjustment improves. To try both TRAMO/SEATS and X-12-ARIMA on the same time series provides an interesting comparison of the filter-based and model-based adjustment. Analysis of revisions and the effects of different types of trading day and moving holiday corrections should also be carried out. Thus, sufficient time and resources should be invested in seasonal adjustment.

Finally, seasonal adjustment is performed to offer better service for the users of statistics. Both statisticians and users of statistics would benefit from a clearly defined framework for seasonal adjustment. Many offices performing seasonal adjustment are facing challenges in controlling the diversity of methods and decisions applied in their seasonal adjustment. Therefore, definition of a clear seasonal adjustment policy is recommended. It may include the choice of seasonal adjustment method, software, the timing of

reanalysis of parameters and seasonal models, treatment of outliers and the practices with revision and dissemination.

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