An Analysis of Industrial Production of the EECCA countries with DEMETRA+

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1. Introduction

The UNECE Statistical Division is launching a programme as part of the United Nations Special Programme for the Economies of Central Asia (SPECA) that aims to strengthen sub-regional cooperation in Central Asia and its integration into the world economy. This programme on "New Challenges in Economic Statistics" will offer support in economic statistics to the National Statistical Offices of Central Asian and Eastern European (EECCA) countries, and Mongolia. The purpose is to promote regional cooperation and harmonization of compilation and dissemination of key economic statistics. International comparability of key short-term economic indicators requires seasonal adjustment techniques to be applied. The programme will include practical training in this methodology. To ensure sustainable results, illustrative working instructions are needed. There are no beginner's instructions on seasonal adjustment at the moment.

Demetra+ is a family of modules on seasonal adjustment, which are based on the two leading algorithms in that domain (TRAMO&SEATS / X-12-ARIMA). The current version of Demetra+ uses TRAMO&SEATS (dated 8/2009) and X-12-ARIMA (recently upgraded by USBC).

The first official release of Demetra+ contains the following applications: Demetra+ itself, WSACruncher[2], Excel add-ins[3], and TSTools[4]. This report only examines the Demetra+ which is the main application.

TRAMO&SEATS and X-12-ARIMA are two different methods to seasonally adjust a time series. Both methods can be divided into two main parts: a pre-adjustment step, which removes the "deterministic" component of the series by means of a regression model with ARIMA(Auto Regressive Integrated Moving Average) noises, and the decomposition step which several components are extracted from a time series. The two methods use a very similar approach in the first part of the processing but they differ completely in the decomposition part. So, their comparison is often difficult, even for the pre-adjustment step. More especially, their diagnostics used in decomposition step focus on different aspects and their outputs take completely different forms.

One of the main features of Demetra+ is to normalize -as much as possible- the different methods. It tries to improve the comparability of the two methods by using a common set of

[2] Console application for batch processing.
[3] Demetra+ integrated in Excel.
[4] It contains a graphical tool for experimental purposes on benchmarking, direct/indirect approach modules etc.

diagnostics and of presentation tools. That fundamental choice implies that a number of routines of both methods have been re-written in Demetra+. That can lead, compared to the original programs, to small discrepancies in diagnostics or in peripheral information that should not alter the general "message" provided by the algorithms. Under no circumstances should the main results of the original programs (i.e. seasonally adjusted series...) be impacted by that solution.

Demetra+ has been designed to handle fast and non repetitive analyses as well as recurrent batch processing. For "transient (or trial)" seasonal adjustments, the software provides several solutions to communicate with external applications in an interactive way, using the usual data transfer channels (drag/drop or clipboard). For batch processing, it provides a sophisticate and extensible solution to load dynamically information coming from various sources, ranging from usual files (text, TSW, USCB... formats) or applications (Excel) to generic database drivers (ODBC) or WEB servers (using a specific xml format).

As a final aspect of Demetra+, which is not considered in this document, is the possibility to use the tool in in-house applications, using the rich "application programming interface" (API) provided by the libraries.

This document is not a complete description of Demetra+. Its only aim is to give basic directions for beginners for performing seasonal adjustment with Demetra+ using the industrial production indexes of the EECCA countries. It is organized as follows: in a first point we shortly describe the different parts of the software; the second point explains the ways of loading Excel data into Demetra+. The next part shows some of the graphical capabilities of the tool. The fourth point is focused on single processing and the last point considers multi-processing.

2. First overview of Demetra+

When it is launched for the first time, Demetra+ appears with the following layout.

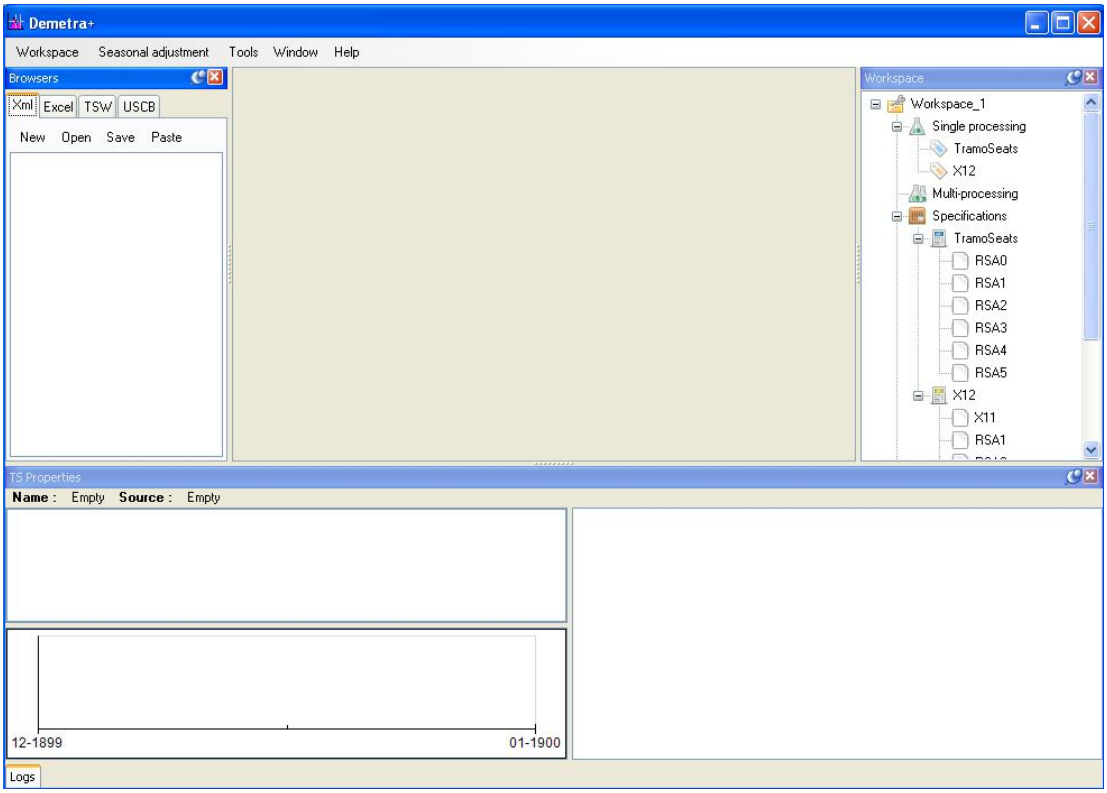


Image 1. The first appearance of Demetra+

The main parts of the application are in Image 1:

- The browsers panel (left panel), which presents the available time series coming from different source.
- The workspace panel (right panel), which shows specifications used (by default in the software) or generated by the user. Also, Calendar and user variables are shown in this part.
- A central empty zone that will contain the actual analyses
- Two auxiliary panels at the bottom of the application; the one (TSProperties) shows the main statistical properties of current time series (selected from the browsers panel) and the second one (Logs) contains logging information (currently, turned off in the Image 1).

The different panels can be moved, resized, superposed or closed[5] following the needs or the preferences of the user. The Image 2 shows different layout of Demetra+.

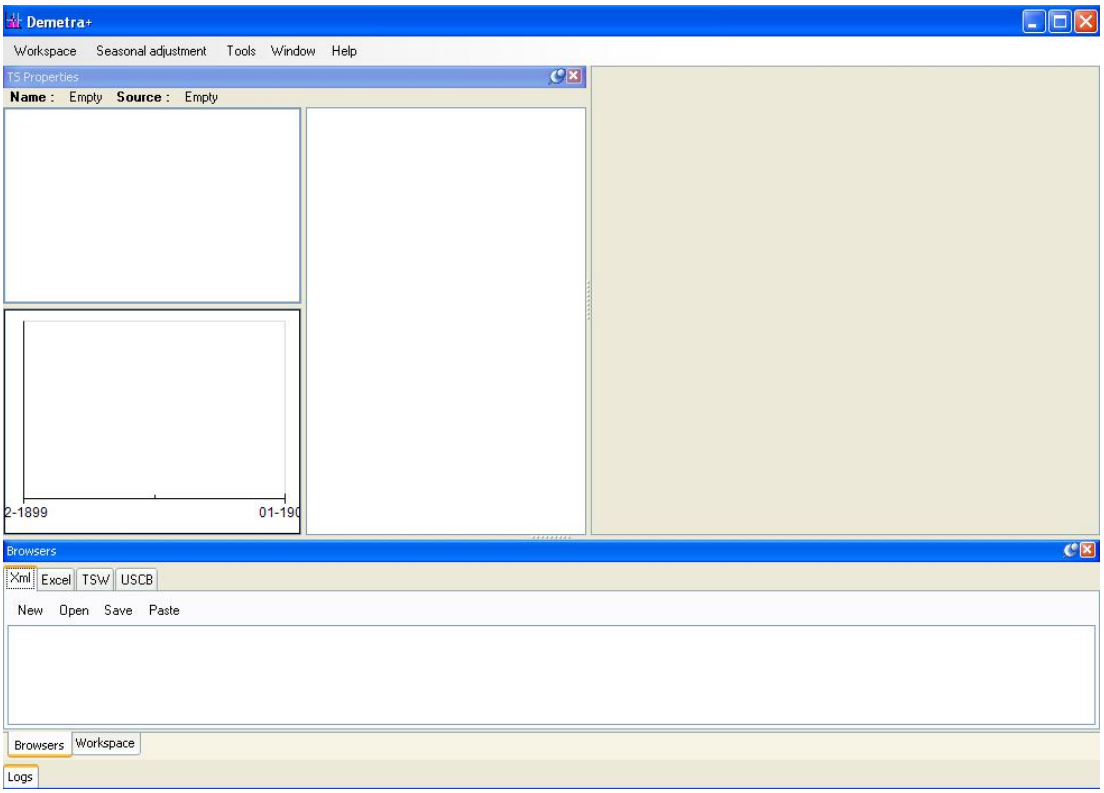


Image 2. A different layout of Demetra+

The application can contain multiple (analysis) documents. Following the needs, you can present them in different tabs taking the full space (default) or in floating windows. The main menu item "Window→ Floating/Tabbed..." gives access to that functionality.

3. Loading a set of series from Excel

Demetra+ is able to handle time series coming from different sources. Only for this paper, I use an Excel file[6] that contains monthly industrial production indexes (2005=100) of the EECCA countries[7]. These data will be used through the whole paper. The properties of dataset are shown in Table 1. As one can see in the table, there are differences in the length and frequency of data between countries. All series in the dataset are appropriate for performing seasonal adjustment since they meet the minimum length criteria stated in the ESS Guidelines on Seasonal Adjustment.

[5] Closed panels can be re-opened through the main menu commands: Workspace->View->...
[6] It should be noted that Demetra+ is compatible with Excel 2003 (xls) as well as Excel 2007 (.xlsx).
[7] All EECCA countries with available data were covered; data were not available for Mongolia, Turkmenistan and Uzbekistan.

Table 1. Some information about the data covered

	Countries	Data Covered		Period	Number of Observations
		Start	End		
1	**Armenia**	Jan-2000	Nov-2010	Monthly	131
2	**Azerbaijan**	Jan-1996	Oct-2010	Monthly	178
3	**Belarus**	Jan-1997	Nov-2010	Monthly	167
4	**China**	Jan-2000	Nov-2010	Monthly	131
5	**Georgia**	Q1-2001	Q3-2010	Quarterly	39
6	**Kazakhstan**	Jan-2000	Nov-2010	Monthly	131
7	**Kyrgyz Republic**	Jan-1993	Oct-2010	Monthly	214
8	**Moldova, Republic of**	Jan-1997	Oct-2010	Monthly	166
9	**Tajikistan**	Jan-1997	Oct-2010	Monthly	166
10	**Ukraine**	Jan-2000	Oct-2010	Monthly	130

We must respect some rules in the layout of our data if we want to be able to launch an Excel workbook in Demetra+. In this application, I consider below a vertical presentation of the series; but a horizontal presentation is also possible and follows, up to a transposition of the cells, exactly the same rules.

In all sheets, the A1 cell must be empty and the A column must contain the reference dates of the observations. *True* dates must be used. So, they don't have to correspond to a specific day of the period they identify; they just have to belong to the considered period. The B1, C1... cells contain the names (or titles) of the series. They must be unique inside a sheet. The cells below each title contain the figures of the series. Missing data should not be indicated by a special value (though the software still accepts -99999, as before), but by an empty cell. Series are identified in a workbook by the name of the sheet that contains them and by their names. That information should not be changed if we wish to be able to re-use analysis based on that workbook.

As indicated in Table 1, we have nine monthly and one quarterly series. Then, I divided data into two sheets to avoid frequency incompatibility within the same sheet. The name of the first sheet is “Monthly”, the second one is “Quarterly”. As can be seen in below Image 3and Image 4, the data are organized to load into Demetra.

	A	B	C	D	E	F	G	H	I	J
1		Armenia / Армения	Azerbaijan / Азербайджан	Belarus / Беларусь	China / Китай	Kazakhstan / Казахстан	Kyrgyz Republic / Кыргызстан	Moldova, Republic of / Молдова, республика	Tajikistan / Таджикистан	Ukraine / Украина
2	Oca.93						75.0			
3	Şub.93						82.5			
4	Mar.93						78.4			
5	Nis.93						89.3			
6	May.93						64.3			
7	Haz.93						47.6			
8	Tem.93						42.4			
9	Ağu.93						55.0			
205	Ara.09	98.6	135.4	135.4	193.9	132.2	177.9	84.1	86.2	88.8
206	Oca.10	86.6	145.2	120.8	150.8	117.0	138.4	59.0	71.2	78.4
207	Şub.10	77.3	127.9	122.0	153.4	106.6	190.0	65.9	68.1	77.9
208	Mar.10	83.3	144.4	129.0	194.9	117.3	139.8	74.5	68.8	91.0
209	Nis.10	81.0	154.0	133.1	193.1	115.3	103.9	60.4	66.3	89.1
210	May.10	75.9	152.0	146.8	195.8	115.5	85.8	67.8	70.1	86.8
211	Haz.10	80.9	144.3	146.8	221.6	117.5	70.7	72.6	68.1	86.5
212	Tem.10	84.5	146.9	149.8	199.0	117.1	92.1	63.7	67.9	89.1
213	Ağu.10	86.4	153.2	143.5	199.3	122.4	73.9	66.6	72.8	90.5
214	Eyl.10	86.5	130.7	156.7	212.3	114.1	115.0	81.4	75.8	93.2
215	Eki.10	88.4	141.0	153.4	207.2	125.0	93.3	88.5	91.1	97.7
216	Kas.10	95.1		160.0	190.6	124.2				
217										
218										
219										
220										

Monthly | Quarterly

Image 3. Data file - Monthly

	A	B	C	D
1		Georgia / Грузия		
2	Mar.01	50.6	1	
3	Haz.01	58.0	2	
4	Eyl.01	54.5	3	
5	Ara.01	56.4	4	
6	Mar.02	54.9	5	
7	Haz.02	62.1	6	
8	Eyl.02	70.4	7	
9	Ara.02	66.9	8	
10	Mar.03	54.0	9	
11	Haz.03	76.7	10	
12	Eyl.03	81.4	11	
13	Ara.03	88.1	12	
29	Ara.07	156.0	28	
30	Mar.08	122.7	29	
31	Haz.08	139.6	30	
32	Eyl.08	127.1	31	
33	Ara.08	134.5	32	
34	Mar.09	108.0	33	
35	Haz.09	101.9	34	
36	Eyl.09	125.1	35	
37	Ara.09	133.9	36	
38	Mar.10	117.6	37	
39	Haz.10	122.4	38	
40	Eyl.10	154.2	39	
41				
42				

Monthly | Quarterly

Image 4. Data file - Quarterly

It is possible to import directly data from Excel by the clipboard or by drag/drop. However, time series imported that way are "dead time series", which cannot be automatically updated. So, I consider here another way, which allows a repetitive use of works. To load the dataset in Demetra+, first go to the “Browsers”, click on the Excel tab in this window and then click on the “Add” button to add an Excel workbook (Image 5). The program opens a standard dialog window (Image 6). When the Excel file selected and pressed “Open”, the name of the Excel file and the number of the series (in the brackets) is shown in the "Excel Browser". The tree in the "Browser" also shows the different sheets of the Excel file and the series in each sheet. By clicking on one of the series listed in the Browsers (for example, Kazakhstan), it may be seen that the “TSProperties” window is changed. Summary statistics (max, min, average, etc.), graphic and data of the series are displayed in Image 7.

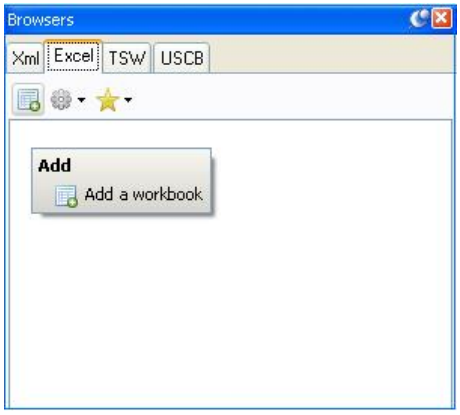


Image 5. Loading data – Step 1

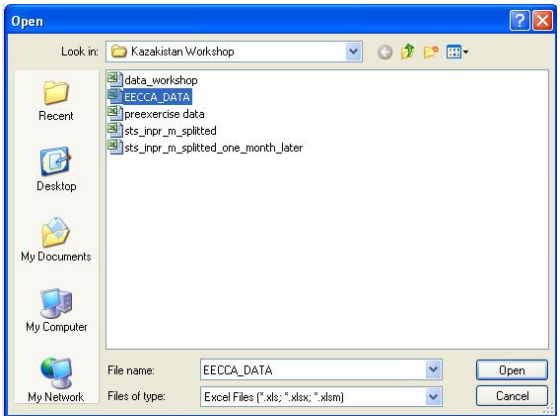


Image 6. Loading data – Step 2

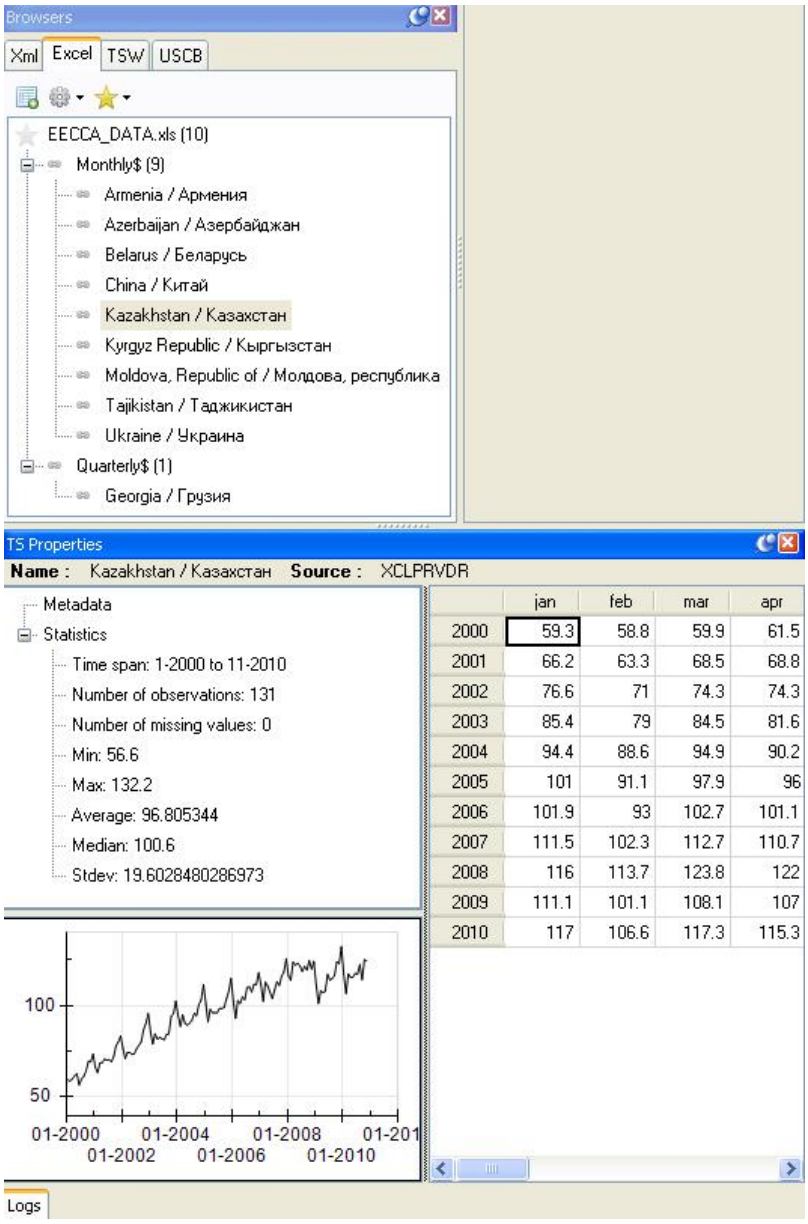


Image 7. View the dataset in Demetra+

4. Visualizing the data and some statistical properties of the series

Before doing a seasonal adjustment it may be useful to take a look at the series and – perhaps - at some of its statistical properties. Consider for instance the Kazakhstan Industrial Production series. To see the figures, I proceed as follows:

- Open a "Grid" window, using the "Grid" item in the "Container" sub-menu under the "Tools" item of the main menu. When it is opened, the "Grid" is empty; it is ready to collect one/more time series.
- Add series to the Grid by drag/drop; in our example, take with the mouse the "Kazakhstan" node of the browser and put it in the grid (display mode and orientation are adjusted in Image 8).

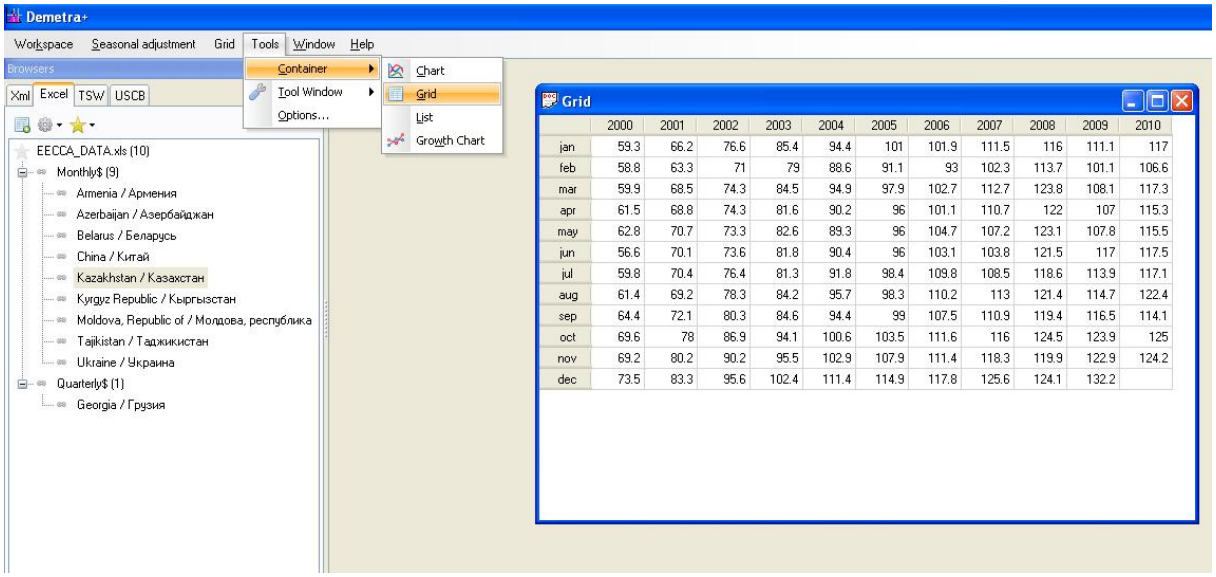


Image 8. Presentation of the data with Grid

The other containers, like “Chart” and “Growth Chart”, are available under the same menu (Image 8). We can use these containers by drag/drop data from “Browsers” as well as from “Grid” (Image 9).

Image 9. Chart and Growth Chart Objects

Some statistical tools, useful to discover properties of the series of interest, are available in Demetra+ in “Tool Window”. They can be used either by dragging/dropping series into them or by "connecting" them to the browsers (“TsProperties” and “Differencing” tool only works under the condition “Connect to Browsers” option is checked). To enable that feature, you have to activate the tool and to check “Connect to Browsers” for the corresponding menu item, and then the tool is then updated each time a new series is clicked.

For instance, let we see how the seasonal chart in Demetra+ is interpreted. To obtain a seasonal chart, we use the “Tools→ Tool Window→ Seasonal Chart”. Then, Kazakhstan’s series is dragged and dropped to the window. Seasonal chart obtained is given below in Image 10.

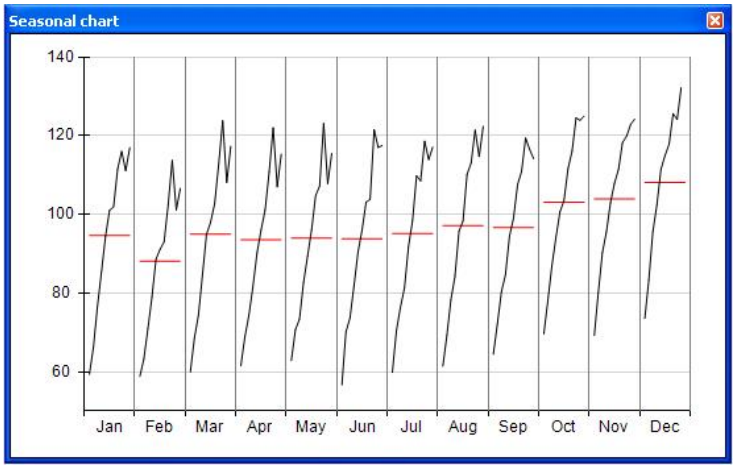


Image 10. Seasonal graph of Industrial Production of Kazakhstan

Seasonal graphs are a special form of line graph in which you plot separate line graphs for each season in a regular frequency monthly or quarterly data. Horizontal lines on the chart illustrate the average of the each period. From the chart, it is seen that the average of February’s is the lowest between the others. On the other hand, December’s average production is the highest. One can expect that these differences between the months affect the interpretation of the data for consecutive periods. For instance, the production index value of March will mostly be higher than of February’s.

Two important tools in the context of seasonal adjustment are dealing with spectral analysis, namely, Periodogram and Auto-regressive spectrum; they are available from the Spectral Analysis tab. If a series has a trend component, Periodogram may show poor results in terms of view but Auto-regressive spectrum is more useful in that case. As a demonstration for the Kazakhstan’s series, the Auto-regressive spectrum graph shows peaks at the zero-frequency (related to the trend component of the series) and at nearly all the seasonal frequencies ($k*\pi/6$, $k=1, 2, 3, 4, 5$) indicated by vertical lavender lines; it doesn’t show a distortion at one of the frequencies related

to trading days effects, which are indicated by vertical violet lines (Image 11). By definition, the peaks on the basic (seasonal and calendar) frequencies in the spectrum chart indicate that the movements re-occur during the period corresponding to that frequency.

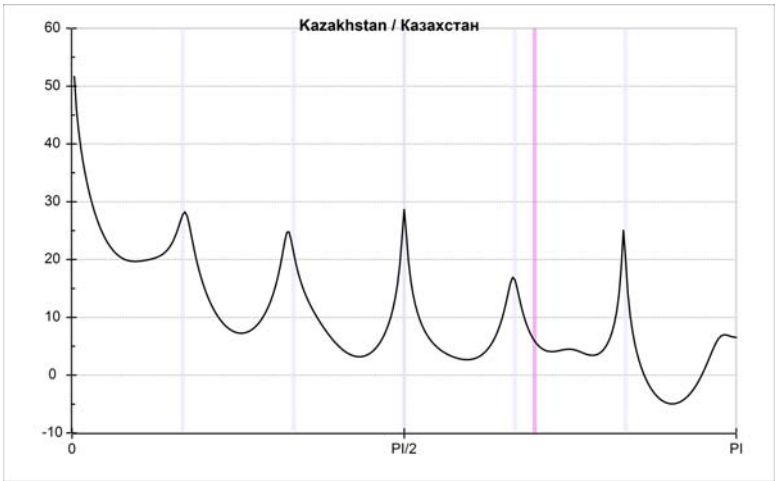


Image 11. Spectrum peaks in the Kazakhstan Industrial Production Index

As a last achievement, Demetra+ provides the "Differencing" tool, which automatically determines the differencing[8] orders of a series; the used method is based on Tramo. It works only when the "connect to browsers" is checked. The "dropping zone" for that tool is represented by the box containing the name of the series, at the top of the window. The estimated regular (D) and seasonal differences (BD) are displayed on top of the tool; they can be changed manually. The differenced series, its graph, its periodogram and its auto-correlation are displayed in sub-windows of the tool (Image 12).

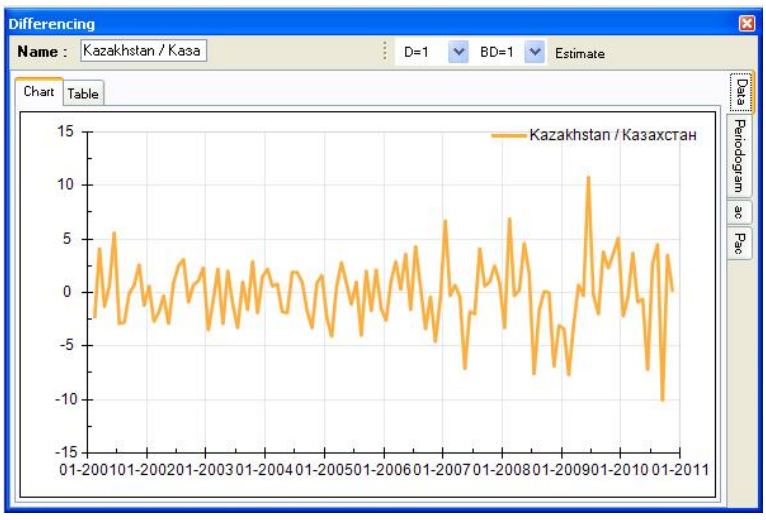


Image 12. Results of Differencing Tool for Kazakhstan's series

[8] Let Y_t is a time series, then regular difference is Y_t-Y_{t-1}, seasonal difference is Y_t-Y_{t-s}, s = number of observations in a year.

As shown in Image 12, the Differencing tool automatically estimated the orders of stationary[9] in regular and seasonal basis. The regular and seasonal difference orders are found 1 for both as outcome. It can be seen clearly that the differenced series is stationary from the graph of the differenced series shown in Image 12 since it has constant mean and (relatively) variance. From this point, we expect that the regular and seasonal difference orders in the ARIMA model used in pre-adjustment stage of both Tramo&Seats and X-12-ARIMA would identify the same orders in their algorithms.

[9] Stationarity means that a series has constant mean and variance during the time. In general, an economic time series is not stationary at its level. To make it stationary, it is differenced at appropriate order.

5. Seasonal adjustment processing

5.1. Single process

5.1.1. Initial setup

Demetra+ offers several ways to seasonally adjust a single series. A first question, which will determine the best way to proceed, concerns the specification that will be used to start the analysis. Demetra+ provides for Tramo-Seats and for X12 a set of pre-defined specifications (using the naming conventions of Tramo-Seats); they are presented in the Table 2.

Table 2. Summary definitions of specifications presented in Demetra+

Method	Name	Explanation
Tramo-Seats	RSA0	level, airline model
Tramo-Seats	RSA1	log/level, outliers detection, airline model
Tramo-Seats	RSA2	log/level, working days, Easter , outliers detection, airline model
Tramo-Seats	RSA3	log/level, outliers detection, automatic model identification
Tramo-Seats	RSA4	log/level, working days, Easter , outliers detection, automatic model identification
Tramo-Seats	RSA5	log/level, trading days, Easter , outliers detection, automatic model identification
X12	X11	No pre-processing, only for decomposition
X12	RSA1	log/level, outliers detection, airline model
X12	RSA2c	log/level, working days, Easter , outliers detection, airline model; pre-adjustment for leap-year if log
X12	RSA3	log/level, outliers detection, automatic model identification
X12	RSA4c	log/level, working days, Easter , outliers detection, automatic model identification; pre-adjustment for leap-year if log
X12	RSA5c	log/level, trading days, Easter, outliers detection, automatic model; pre-adjustment for leap-year if log identification.

The default specifications appear in the workspace tree. It is strongly recommended to the users to start their analysis - as explained below - with one of those specifications (usually RSA4(c) or RSA5(c)) and to change afterwards some of the options, if need be.

When a user wants to use in a frequent way a specification that is not available in the list of the predefined ones (for example if he wants to integrate systematically its own calendar variables or if he wants to exclude (some kinds of) outliers, the best solution consists in defining it and in adding it to his workspace. That can be done as follows: In the “Seasonal Adjustment” item of the

main menu, choose the “Specifications” sub-menu, and click on “Tramo-Seats specification...” or “X12 specification...”After that you have chosen all the suitable options in the "Specifications" dialog box, the new specification is automatically sent to the corresponding node of the “Workspace”. The new specification will be saved with the workspace, for future use. It can be used exactly like any predefined specification.

Finally, if the user wants to use just for one analysis a specification that is not available in the list of the predefined ones, he should go to the wizard for single seasonal adjustment, which is also described below.

5.1.2. Creation of a single processing

The user can create a single processing, i.e. seasonally adjust a single time series, either using the main menu or using only the mouse. We consider first the last solution, which is usually the fastest and the simplest one.

Creation of a single processing by a double click in the browsers

When a series is double-clicked in one of the browsers, a single processing is automatically launched, following a logic explained below:

If no (unlocked) single processing window is opened, a new one is created. If an active specification has been defined in the workspace, it is used for the new processing. The user can choose a specification (making active with a mouse right click) in the workspace tree by means of its local menu. If the workspace doesn't contain an active specification, a small dialog box will invite the user to choose it. If single processing windows have been previously opened, they will all be updated with the new series, even if they don't correspond to the active specification.

Creation of a single processing by the drag/drop of a specification in the central panel

The user can also create any single processing that correspond to a specification (default or user-defined) that appears in the workspace. He only has to drag/drop it in the central panel of the application. A new single processing window will open automatically. The data can be imported into that window either by a double click on a series of the browsers (but all other windows will also be updated) or by dragging/dropping the series in the left panel of the single processing window.

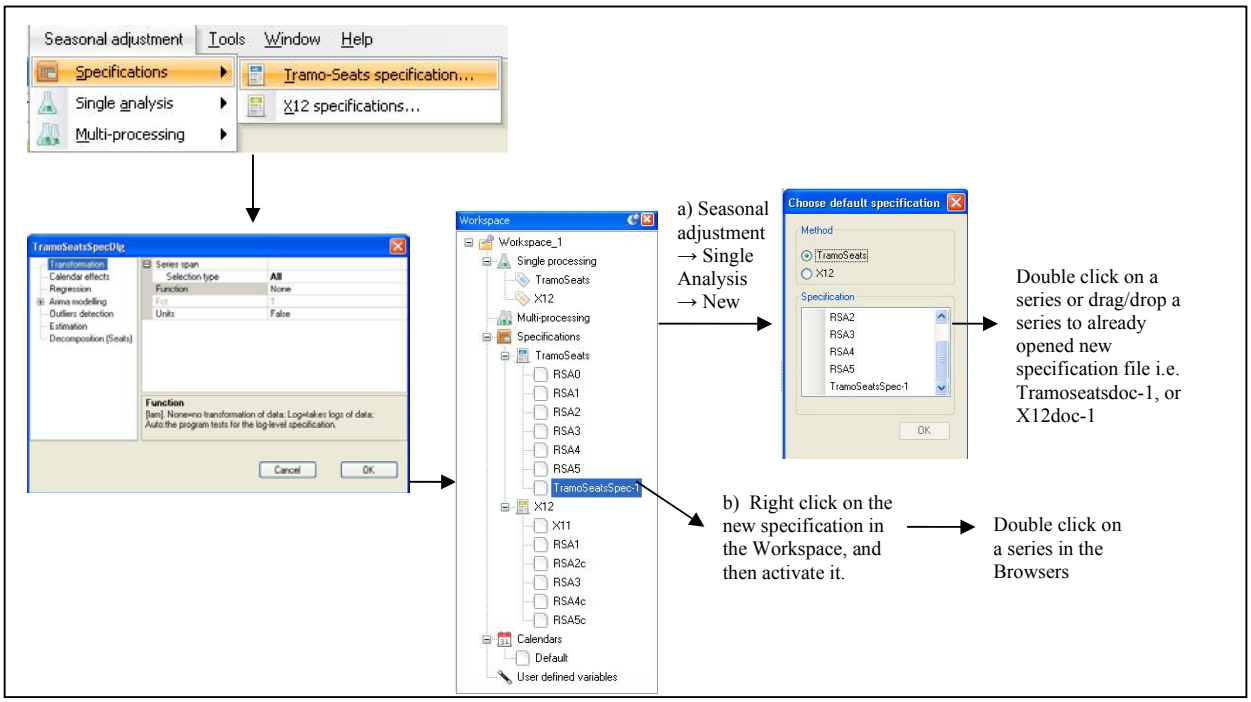
Creation of a single processing by the main menu

A new single processing can be created by selecting the main menu item: "Seasonal adjustment → Single Analysis → New". If an active specification has been defined, the new single processing will correspond to that specification. Otherwise, just as it is explained above, a small dialog box will invite the user to select it.

Short summary

We summarize in Diagram 1 the different steps that a user should follows to create a single analysis, with its own specification, for instance, of Tramo-Seats.

Diagram 1. To create a single process with own specification



Creation of a single processing by means of the wizard

A last option for the creation of a single processing consists in using the "Wizard" by means of the main menu item (Image 13): "Seasonal adjustment → Single Analysis → Wizard". In the Wizard, the user can choose the series he wants to analyse and he can create its own specification or use a default/pre-defined ones.

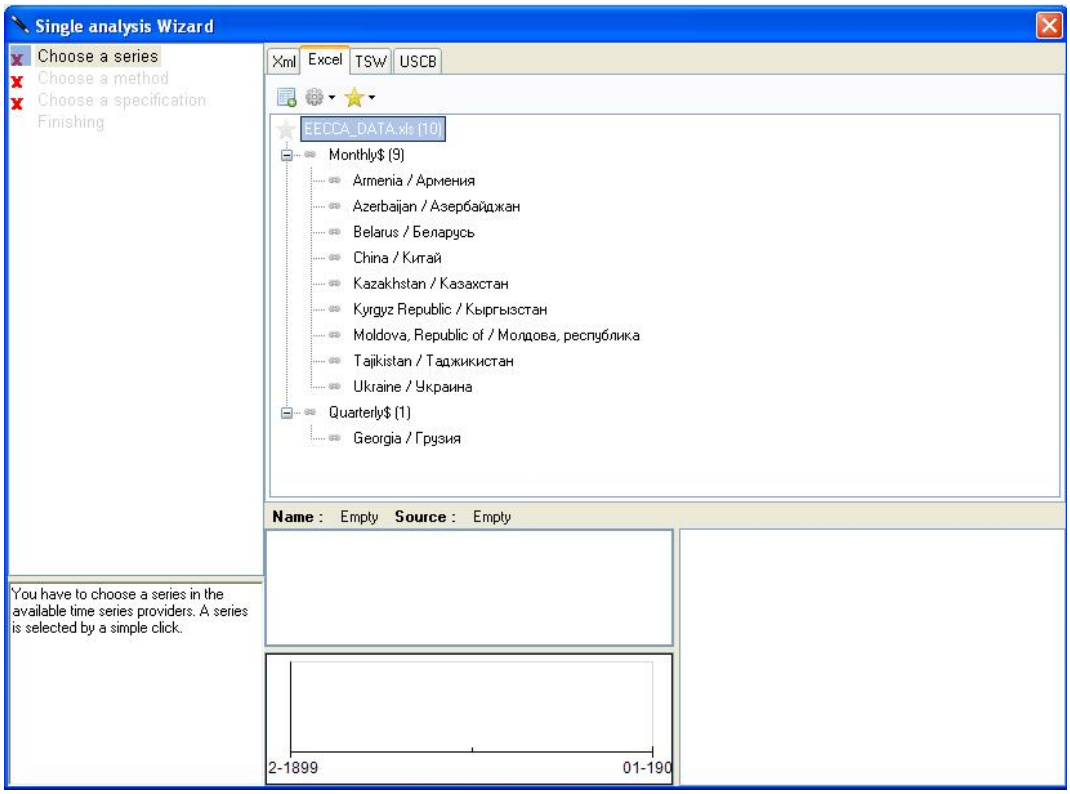


Image 13. A screenshot from single processing wizard

5.1.3. Application

I use the industrial production series of Kazakhstan in the example data set. The seasonal adjustment is performed by creating my own TRAMO&SEATS specification via the menu "Seasonal Adjustment – Specifications". The parameters in the TramoSeatsSpecDlg dialog box are set up as shown in Table 3.

Table 3. Own specification used in single processing

Options	Set	Definition
Transformation→Function	Auto	Program will test for log/level specification
Calendar effects→ Trading days →Type	Predefined	
Details→ Trading days	td2	Working-day and leap year
Pretest	True	Program tests whether the effect is significant or not.
Easter effect → option	Pretest	Program tests whether the effect is significant or not.
Duration.	6	Duration of Easter
Arima modelling → Automatic modelling → Enabled	True	The program automatically identifies the orders of ARIMA model
Outlier detection → Enabled	True	The program automatically detects the outliers

By clicking OK, a new specification is created and added to the “Workspace”, under the "Specifications -> Tramo-Seats" node. By default, it is called TramoSeatsSpec-1. It is activated by means of the local menu (called with a mouse right click). Last, double click on the industrial production series of Kazakhstan.

5.1.4. Getting results

By default, Demetra+ presents all the results computed by the software (but it is possible to hide unwished panels). There are 4 main parts i.e. Main results, Pre-processing (TRAMO), Decomposition (SEATS) and Diagnostics. The results of X12 are organized in a similar way (expressions in the brackets of “Pre-processing” and “Decomposition” are changed to Reg-ARIMA and X-11, respectively).

Main Results

The Main Results page contains a short description of the used model and of the quality of the seasonal adjustment. According to results obtained by analysis of Industrial production series of Kazakhstan with the specification defined before, we can see that in Image 14:

- Estimation span is between Jan-2000 and Nov-2010,
- Log-transformation is selected,
- Neither working day nor Easter effects are significant. Also, leap year effect is not significant,
- Outlier detection procedure detected 3 outliers in the series,
- Variance of seasonal and trend components are lower than irregular component's. It means that smooth trend and seasonal components are obtained. Hence, it can be said that the assumption of canonical decomposition is hold,
- The analysis seems to satisfy all the diagnostics, except the visual test on spectral seasonal peaks; it should warn the user about a possible misspecification of the seasonality. But, it needs detailed analysis.

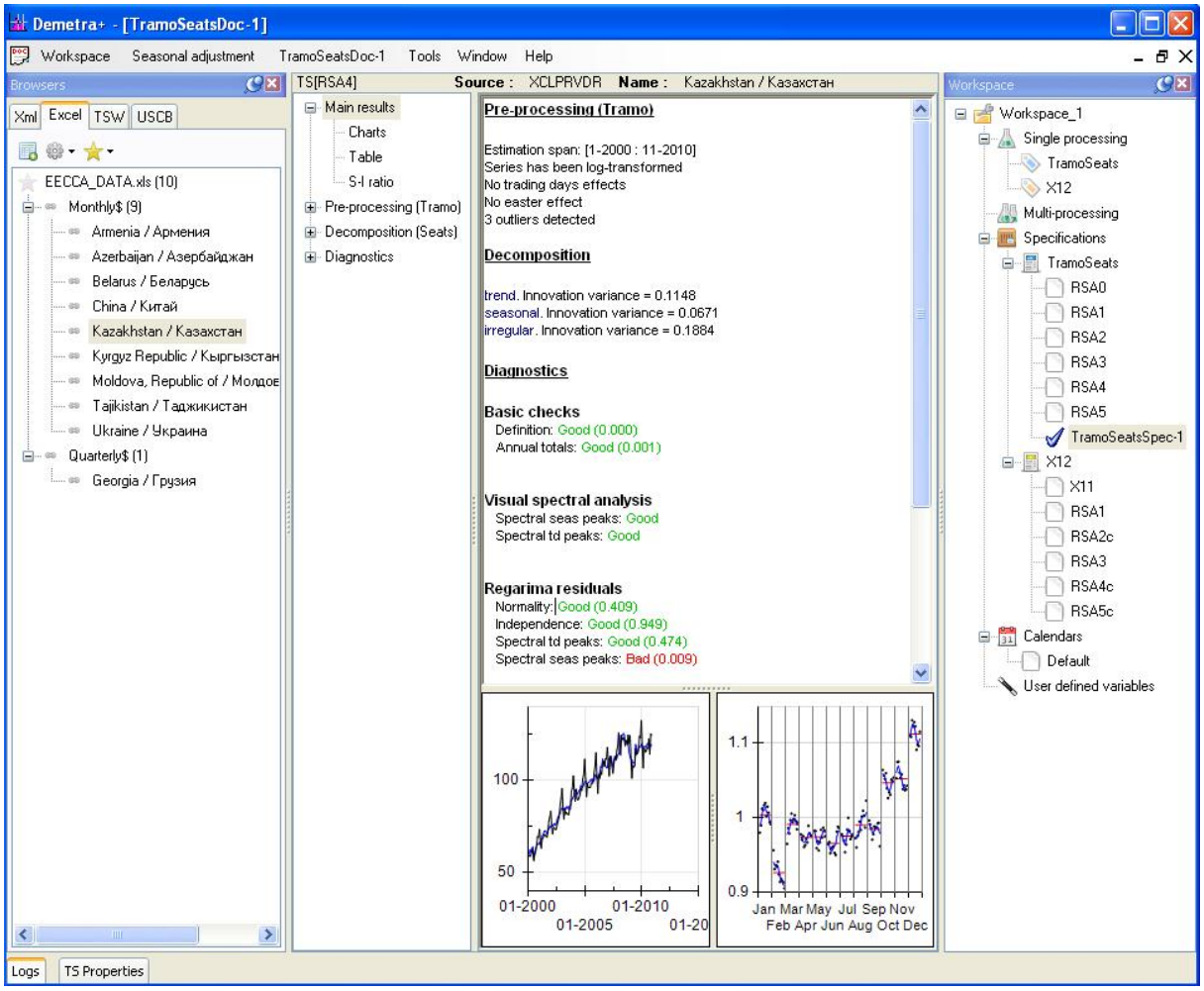


Image 14. The view of results obtained by single analysis

In the panels under the "Main Results" node, the S-I ratio chart provides one of the most useful descriptive view of the decomposition (Image 15). By double-clicking on a specific period, it is possible to get a more detailed view of its seasonal pattern. The charts below clearly indicate the months that present unstable or moving seasonal factors (see for instance January in Image 16).

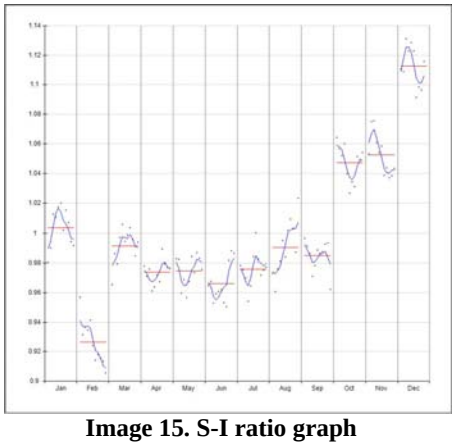


Image 15. S-I ratio graph

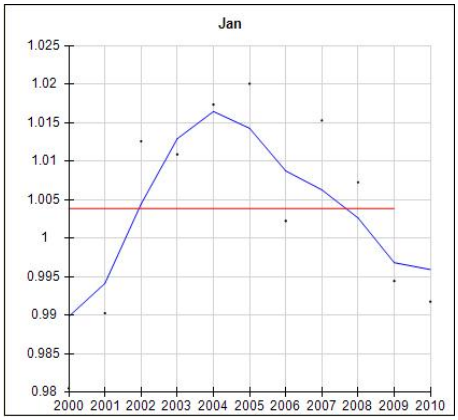


Image 16. Focused S-I ratio for January

Pre-adjustment

Description and properties of pre-adjustment step are given in the "Pre-processing" panels. It contains information listed below:

- Statistical properties of Arima model used in the analysis
- Regression variables and their coefficients (if any)
- Tables of pre-adjusted series
- Residuals, with a complete analysis of their statistical properties, based on the diagnostics developed in Tramo.

For Kazakhstan's series, the identified ARIMA model is an Airline model $(0,1,1)(0,1,1)_{12}$. Regular MA parameter is significant at % 1 significance level while Seasonal MA is not significant at even %10. The routine has detected one transitory change (June-2000) and two level shifts in June-2009 and Feb-2008. The diagnostic tests on residuals don't suggest statistical problems (Image 17). All null hypothesises of statistical test are accepted at % 5 significance level. Hence, we can say that residuals are distributed as random, normal and independent. Residuals do not show non-linearity in terms of tendency according to results of non-linearity test.

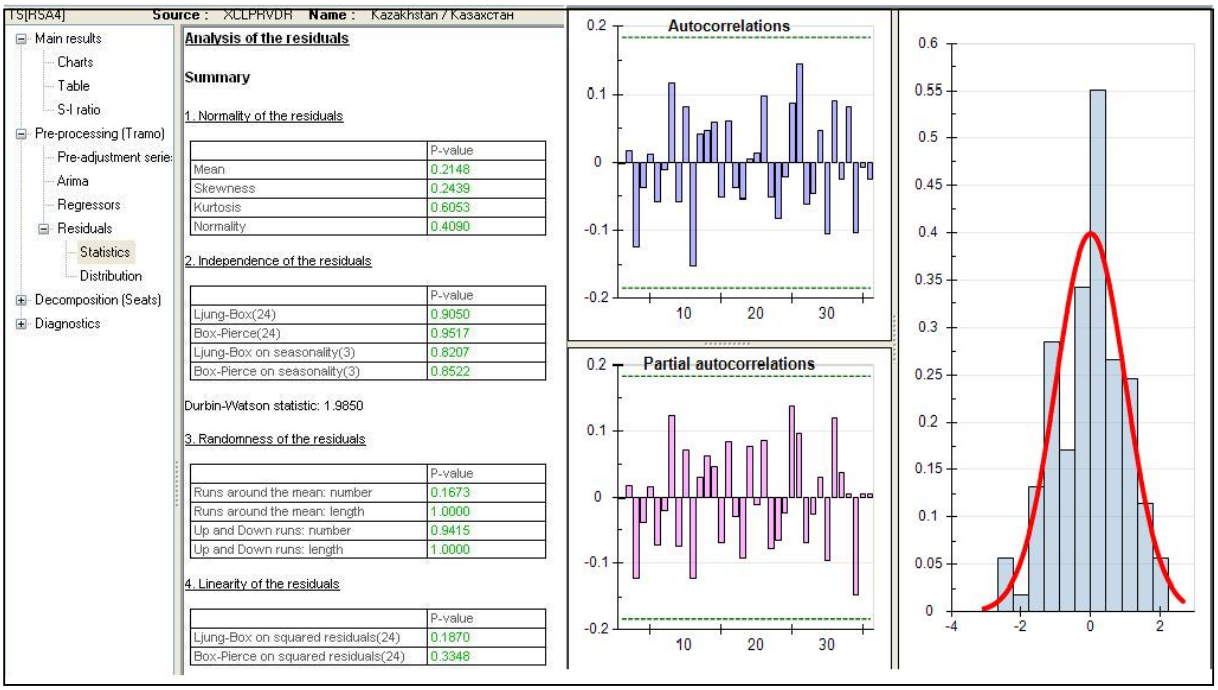


Image 17. Test statistics and distribution graph of the residuals

Decomposition

The "Decomposition" panel contains the ARIMA models which are defined by SEATS. The sub-panels of that part of the output present, for SEATS, many properties of the Wiener-Kolmogorov filters which extract the components (trend-cycle, seasonal etc.) from original series by means of canonical decomposition. Canonical decomposition provides the extracted components should be uncorrelated. For X-11, Demetra+ provides the detailed tables namely, A, B, C, D, and E which contain the results of consecutive stages of X-11 procedures.

SEATS results obtained from seasonal adjustment of Kazakhstan's series, in the Decomposition (SEATS) part, contain the models for each component. According to results;

Main model : $\Delta^1\Delta^{12}x_t = (1 - 0{,}12B)(1- 0{,}55\ B^{12})a_t$, $\sigma^2_a=1$

Trend model : $\Delta^2x_t = (1 + 0{,}049B - 0{,}95B^2)\ a_{p,t}$, $\sigma^2_p=0{,}115$

Seasonal model : $(1+B+B^2+B^3+B^4+B^5+B^6+B^7+B^8+B^9+B^{10}+B^{11})s_t = (1+1{,}72B+1{,}99B^2+2{,}04B^3+1{,}88B^4+1{,}61B^5+1{,}29B^6+0{,}95B^7+0{,}64B^8+0{,}33B^9+0{,}14B^{10}-0{,}19B^{11})\ a_{s,t}$, $\sigma^2_p=0{,}07$

Irregular : White noise (0 ; 0,19)

Above, Δ is difference operator, B is lag operator ($B^1x_t = x_{t-1}$). σ^2 is proportional variance of innovations of relevant component. SEATS identifies an ARIMA model for each component in time series. As seen above, there are three ARIMA models identified for the Kazakhstan industrial production series. Main model is decomposed to three sub-models which are trend, seasonal and irregular. Trend model is IMA(2,2). From the moving average part of trend model, it can be proved that the trend model is invertible. AR part of seasonal model is the sum of seasonal lags up to degree s-1 which is "s" is the number of period. Finally, irregular component is white noise with zero mean and variance 0,19 .

Demetra+ provides extracted components (result series) under the "Stochastic series" tab. One can find there seasonally adjusted series, and trend, seasonal and irregular components. In terms of diagnostics of SEATS, Demetra+ gives the distribution of components, theoretical estimator and empirical estimate in stationary transformation. Also, a table of cross-correlation between the components is given as useful information to test whether the components are correlated with each other. Given that the assumptions of canonical decomposition, there is no correlation between the estimated components. A cross-correlation example for this application is

given below in Table 4. Cross correlation is important since canonical decomposition assumes that the components are uncorrelated. Hence, cross correlation results are the way to test this assumption.

Table 4. Cross-correlation results

	Estimator	Estimate	P-Value
Trend/Seasonal	-0,1250	-0,1504	0,8018
Trend/Irregular	-0,0450	-0,0856	0,7311
Seasonal/Irregular	0,0446	0,0195	0,5900

It should be noted that, for the Wiener-Kolmogorov filters, Demetra+ displays advanced tools like the estimation of phase delays. A phase delay is the time shift between the filtered (seasonally adjusted or trend-cycle) series and the unfiltered series. A positive phase delay means that the filtered series is shifted backwards and a negative phase shift it is shifted forwards in time. Phase delaying occurs when timing of turning points is distorted, for example when the moving average is placed off-centre by the asymmetric filters. That is they will occur either earlier or later in the filtered series, than in the original. It is important for filters used to derive the trend to retain the time phase, and hence the timing of any turning points. For the considered series, the next chart shows that, at the end of the series, the decomposition generates a phase delay effect of 3 months on the seasonally adjusted series and on the trend (Image 18).

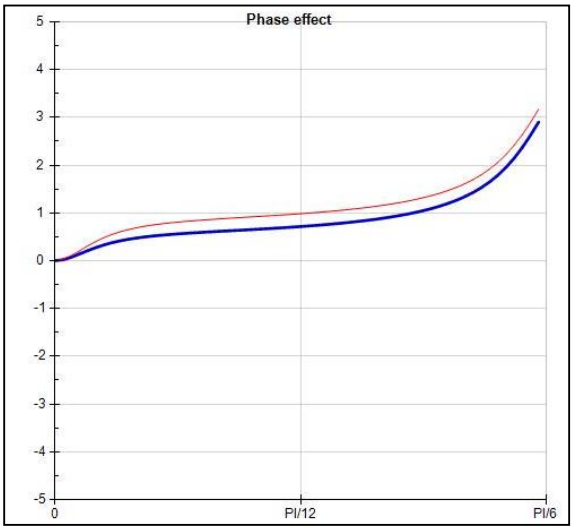


Image 18. Phase-delay effect of seasonal adjustment

Diagnostics

The "Diagnostics" panels present very detailed information on the seasonal adjustment procedures; that information -often purely descriptive- is computed the same way for Tramo-Seats and for X12. The diagnostics are divided in five main parts.

The first one is about the existence of seasonality in original series and residuals from Tramo/RegArima. The series to be seasonally adjusted have to contains seasonal component. Otherwise, there is no mean to perform seasonal adjustment. These tests are non-parametric seasonality tests (Friedman and Kruskall-Wallis), stable seasonality test and "evolutive" seasonality test which is a combined test provided in X12 is also computed for Tramo-Seats. On the other hand, the seasonal adjusted series should not have a seasonal component after having performed seasonal adjustment. Statistical information about the residual seasonality is provided at the end of the panel. For the considered series in this application, results of seasonality test are given in the Image 19.

Evolutive seasonality test

	Sum of squares	*degrees of freedom*	*Mean square*
Between years	0.0028	9	0.0003
Error	0.0117	99	0.0001

Value: 2.6270
Distribution: F-stat with 9 degrees of freedom in the numerator and 99 degrees of freedom in the denominator
P-Value: 0.0091
Moving seasonality present at the 5 per cent level

Combined seasonality test

Identifiable seasonality present

Residual seasonality test

No evidence of residual seasonality in the entire series at the 10 per cent level: F=0.1024
No evidence of residual seasonality in the last 3 years at the 10 per cent level: F=0.4541

Image 19. Existence of seasonality test for the series of Kazakhstan

Looking at the Image 19, it can be said that moving seasonal component is present, at the 5% significance level, in the industrial production series of Kazakhstan. Seasonality is identified in the original series, but nor the entire series neither the last 3 years of the seasonal adjusted series has residual seasonality. The presence of a moving seasonality is not a surprise, considering the S-I ratio chart described above.

The second part of the "Diagnostics" presents spectral graphics (periodograms and auto-regressive spectrum) of the residuals, irregular component and seasonal adjusted series (made stationary by differencing). All those graphics are used to check the presence of abnormal peaks at

the seasonal (lavender lines) and/or trading day frequencies (violet lines). Peaks at the seasonal frequencies mean that the filters used in the decomposition are not well adapted to the series (at least in a large part of it), while peaks at the trading days frequencies could indicate that the regression variables used (or not used) in the model are not the best ones or that the calendar effects are changing too much to be captured by fixed regression effects on the whole period of estimation.

Regarding the series of Kazakhstan, it may be suggested that there is no indication of residual seasonality and residual calendar effects in seasonally adjusted series, because no spectral peaks are found in seasonal and trading day frequencies (Image 20). But, it can be seen that there is a peak in a very short-term frequency. Usually, peaks on other frequencies cannot be easily interpreted and are not important in terms of seasonal adjustment.

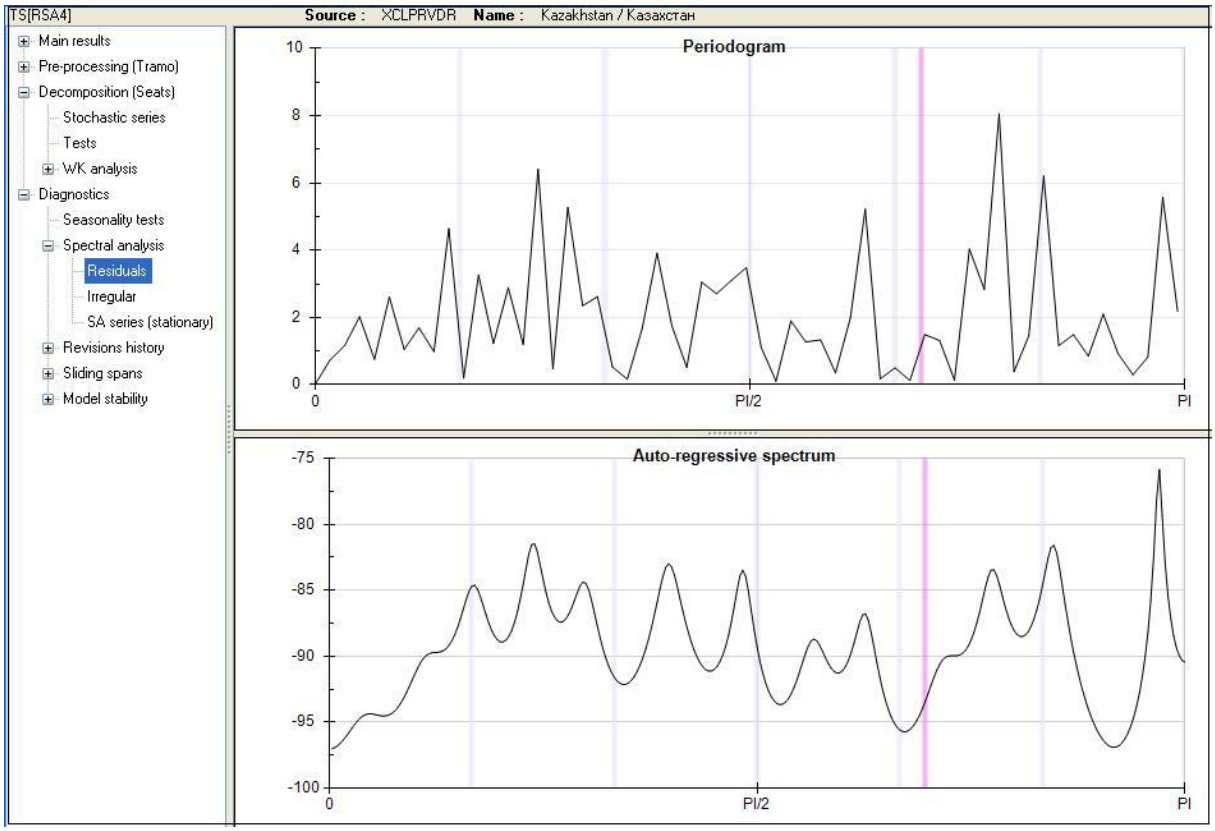
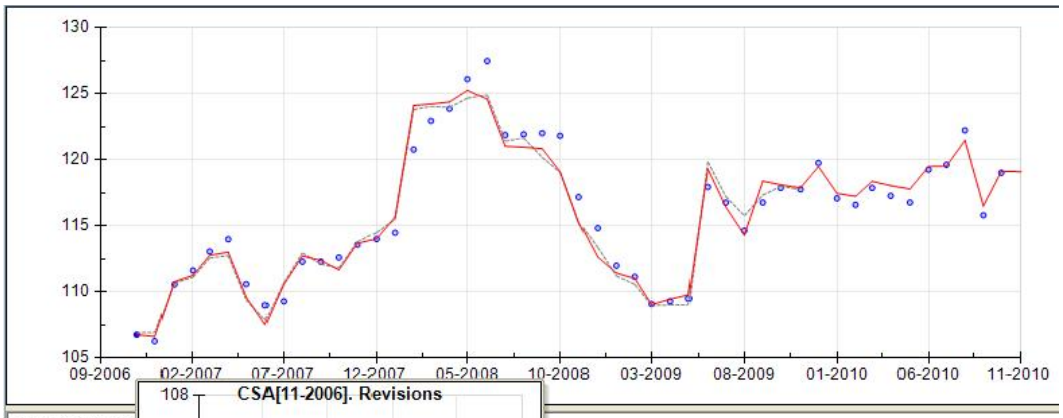


Image 20. Spectrum graphics of residuals obtained from Tramo

It should also be stressed that it is difficult to build statistical tests on such information. The only exception concerns the periodogram of the residuals whose values should be under the null hypothesis of white noises, distributed as a $\chi^2(2)$. A limit for abnormal values is indicated, on that chart, by a horizontal yellow line.

The third part of the "Diagnostics" presents the revision history of the series of interest. A processing may be considered as "stable" if removing or adding data points at the end of the series does not affect the result. Most of the time, the stability of a seasonal adjustment is a good indicator of its quality. However, it can happen that the "best" seasonal adjustment is an unstable one. In such a case, the user should decide whether stability or quality of seasonal adjustment is more important.

Demetra+ provides "Revision history" for TRAMO&SEATS as well as X-12- ARIMA. The analysis is built as follows: starting from the model estimated for the complete time span, noted [t0, t1]. Demetra+ shortens progressively that time span and re-estimates the decomposition. By default, only the parameters of the model are re-estimated. However, the program allows a complete re-estimation or a re-identification of the outliers; those options can be activated by means of the local menu on the nodes of the revision history. For each period, a series of successive estimations are obtained by the procedure explained above. The first one which corresponds to, from the period "t" to the estimation on the time span [t0, t], is indicated by a blue circle. The last one, computed on [t0, t1] and corresponding to the current estimation, appears on the red line.



				2009	2010
January				-0.497	0.317
February				-0.122	0.553
March				-0.039	0.420
April				0.147	0.659
May				0.247	0.871
June		-1.336	-2.263	1.153	0.196
July		1.168	-0.690	-0.270	-0.088
August		0.384	-0.802	-0.296	-0.619
September		0.084	-0.961	1.384	0.598
October		-0.839	-2.232	0.201	0.091
November	0.000	0.092	-1.681	0.099	
December	0.334	0.008	-1.904	-0.229	

Image 21. Revision analysis

In the Image 21, by clicking on a blue circle (for instance, 2006-11) of the graph, an auxiliary window will appear; it shows the successive estimations (computed on [t0, 2006-11], [t0, 2006-12]... [t0, 2010-1]) of the considered series (seasonally adjusted series) for the period 2006-1.

From the auxiliary graphic of the industrial production series of Kazakhstan, it appears that revisions are not significant after 3 years; the annual pattern of the revisions appears also clearly. In our example, the sudden change in the estimations of the seasonally adjusted figures for February 2008 when new observations became available is linked to the level shift that appeared at that time in the series.

The revision history window also contains a table with the differences between the first estimates and the last estimates for the last four years. If the decomposition is additive, absolute revisions are used, otherwise, relative differences are considered. The largest differences are displayed in red. They correspond to values that are larger (in absolute term) than 2 times the root mean squared error of the (absolute or relative) revisions. According to results of considered series, there are 4 data points in the year 2008 which are out of the critical bound defined before. It should be noted that 3 of them are outliers.

In the fourth part of the diagnostics, the "Sliding Spans" analysis, as it is defined in the original X12, is computed. The program sets up 4 spans of 8 years, separated by 1 year. The seasonal and the trading day's panels compare the (relative) changes of the levels of those components. The SA changes panel is related to period to period changes. When an additive decomposition is used, the sliding spans analysis uses absolute differences. The threshold to detect abnormal values is set to 3% of the RMS of the original series. A value of more than 3% is regarded as unstable. As seen in the Image 22, according the sliding spans analysis of considered series, it may be suggested that the seasonal factors of the series are stable since none of the relative differences are higher than 3%.

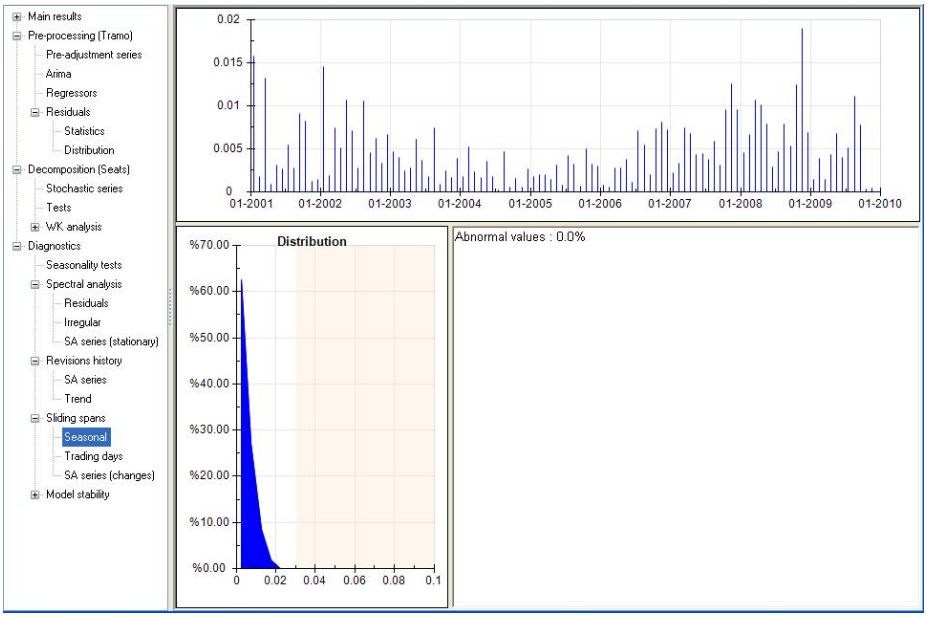


Image 22. Sliding spans analysis

The last part of the diagnostics presents the “Model stability” analysis which calculates ARIMA parameters and coefficients of the regressors for different periods and visualizes these results on the graphics is shown at the last part of the diagnostics. The model stability is computed as follows. The parameters of the model defined on the complete time span is computed on a moving window (8 years), which is sliding year by year. The displayed points (trading days, parameters...) correspond to the successive estimations.

Value of ARIMA parameters which are computed for each span, for example, 2000-2008, 2001-2009 and 2002-2010 are given for the industrial production series of Kazakhstan, below; regular MA and seasonal MA parameters are estimated for 3 different period (Image 23). In the Airline model, it is known that regular MA parameter represents the structure of trend component; seasonal moving average parameter represents structure of seasonal component. The graphic shows an unstable (from negative to positive) regular moving average parameter, but a seasonal moving average parameter that evolves in a rather small range.

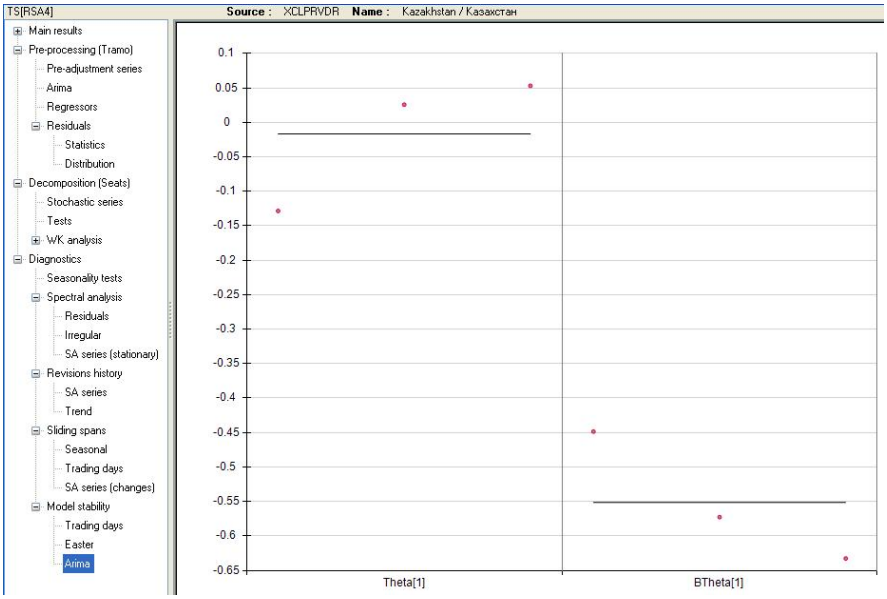


Image 23. Model stability analysis

5.1.5. Modification of the specifications

Making a seasonal adjustment is usually an iterative process. We start often with a specification that gives a large freedom to the software (or, in other words, we try to find our "best model" in a very large set of possible models) and, if need be, we progressively impose to our specification some constraints (we restrict the field of the possible models). One of the main features of Demetra+ is to allow such an approach in a very interactive way. For each analysis, it is

possible to get the specification used to get the results (current specification) or the specification that corresponds to the results (apart from the estimated parameters), to change any option and to see immediately its effect on the processing. The dialog box given in the Image 24 on the specification is launched by means of the main menu. It corresponds to the current active single analysis.

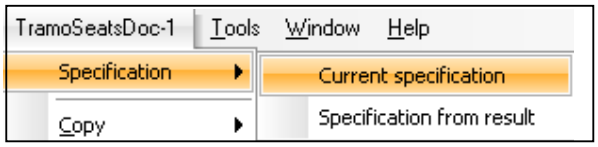


Image 24. Modification of results

5.2. Multi-process

5.2.1. Initial setup

Demetra+ is able to perform seasonal adjustment of a (potentially large) set of series; such a task is called a "multi-processing"; it is defined by a set of pairs of series and specifications. Demetra+ accepts "multi-processing" that mix different seasonal adjustment methods. Creating a multi-processing consists in defining the set of series and specifications. The software provides two different ways to perform such a task. The first solution is based on the "active" specification; in that solution, the series that a put in a multi-processing are automatically associated with the "active" specification. The second solution consists in using a wizard, which allows the users to associate series and specifications step by step.

Creation of a multi-processing by means of the "active specification"

The simplest way to create a multi-processing is based on the use of the "active" specification. We recall that the active specification can be selected in the workspace through a local menu; it can be either a pre-defined specification or a user-defined one. A new empty multi-processing is created by the "New" menu item under the "Multi-processing" sub-menu. The user can drag and drop any series or group of series in the multi-processing window. Those series are automatically associated with the "active" specification. For instance, if we want to process all industrial production indexes of the EECCA countries (all 10 series) with TRAMO&SEATS(RSA4), we first have to activate that RSA4 specification in the workspace tree and then to drag/drop the corresponding nodes (Monthly and Quarterly) in the window (Image 25).

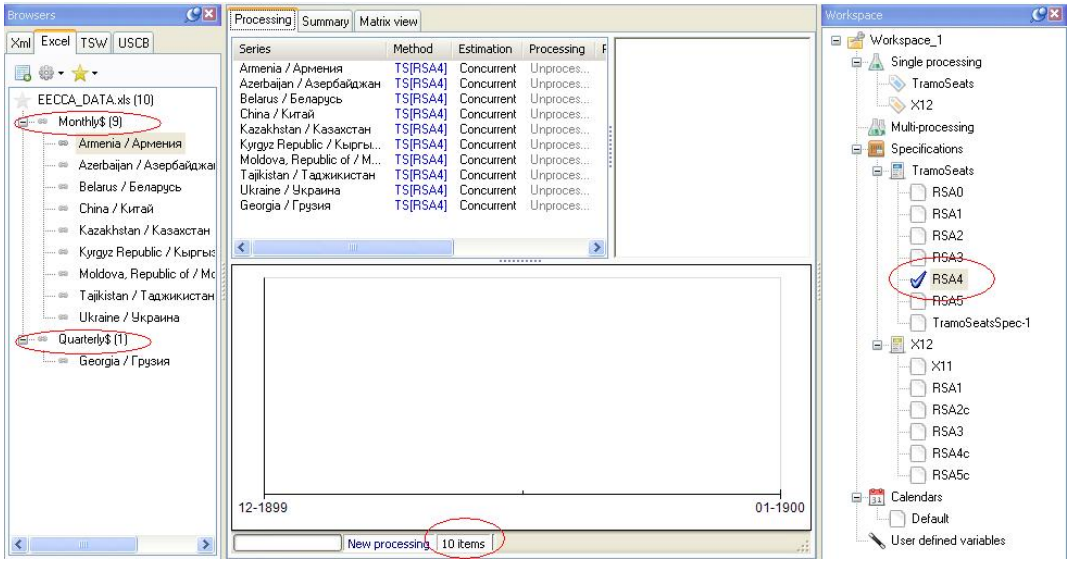


Image 25. Creation of new multi process

The processing is actually launched by means of the “Run” command under the "SAProcessing-1" main menu item (Image 26).

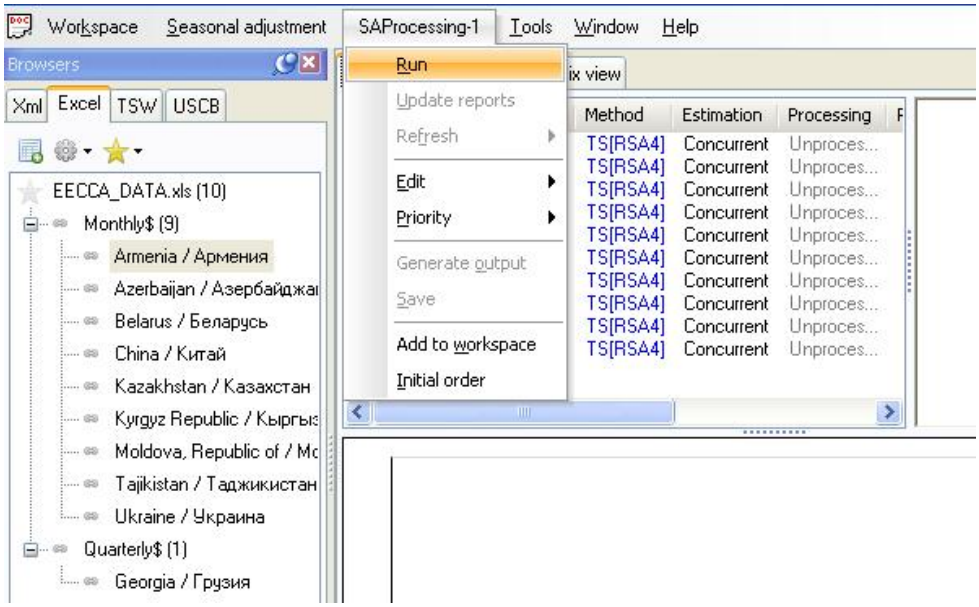


Image 26. To run the multi-processing

Creation of a multi-processing by means of the wizard

The same goal can be achieved through the "Multi-Processing Wizard" (Image 27). The wizard guides the user in the construction of the associations "series-specifications". It also gives him the possibility to define and to use specifications that don't belong to the workspace.

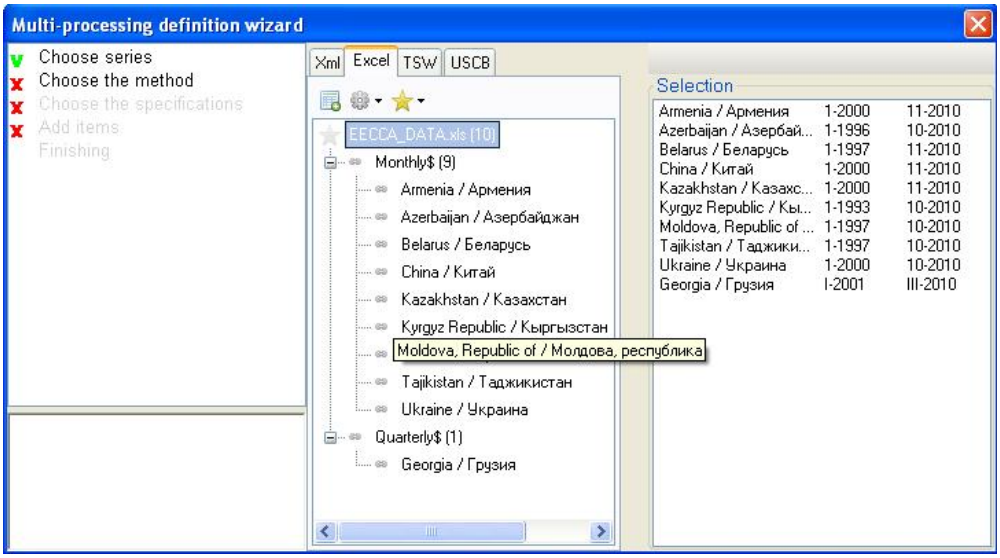


Image 27. Using wizard to create multi-process

At the last stage of the wizard ("Finishing") the user can modify the name of the multi-processing (SAProcessing-xx, default); he can also add the multi-processing to his workspace, for future re-use (see later) and he can decide if the execution is automatically started (the default) when the wizard is closed (Image 28). It should be mentioned that he can go back to the first step of the wizard at any time, if he wants to add other series with other specifications.

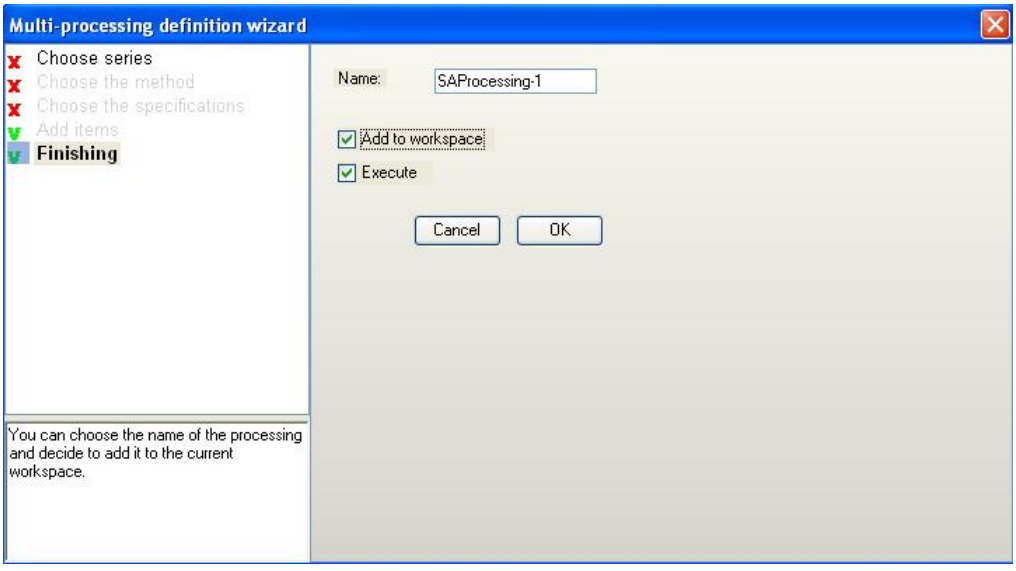


Image 28. Finishing the wizard with adding the specifications to workspace

5.2.2. Application, diagnostics and main results

The first panel of the multi-processing window (Image 29) gives an overview of the processing of each series and more especially of the diagnostics computed by Demetra+ on its seasonal adjustment; some warnings can also be put forward, for short series, non-decomposable

models (SEATS) or when the differenced series doesn't show seasonal peaks. Information on those warnings is displayed by a tip on the series.

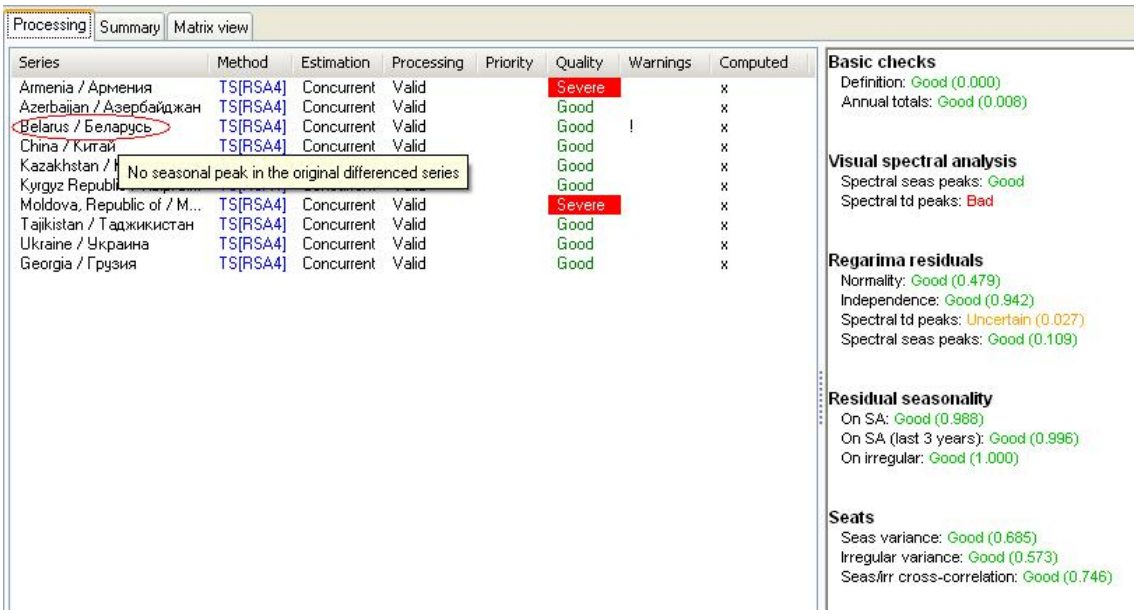


Image 29. Warnings for the multi-process

According to tip appeared on the industrial production series of Belarus, Demetra+ with specification RSA4 of Tramo-Seats can not detect any seasonal peak in the original differenced series. It may mean that there is no significant seasonality in the original series. By the way, according to the preliminary results obtained from the analysis, seasonal adjustment can be well performed for all countries, with the exception of Armenia and Moldova. For these two countries, their residuals obtained from pre-adjustment step (Tramo) may contain seasonal peaks since the corresponding diagnostic shows “Severe”.

By clicking on the name of a series, a short summary of the diagnostics is displayed on the right part of the window and the final seasonally adjusted series appears in the chart at the bottom of the window. A very raw description of the used model is also provided in the status bar of the window. The complete details for a series can be obtained by a double click on the name of that series (when the window for the details is opened, changing the selection in the multi-processing window will automatically adapt the details to the new selected series)

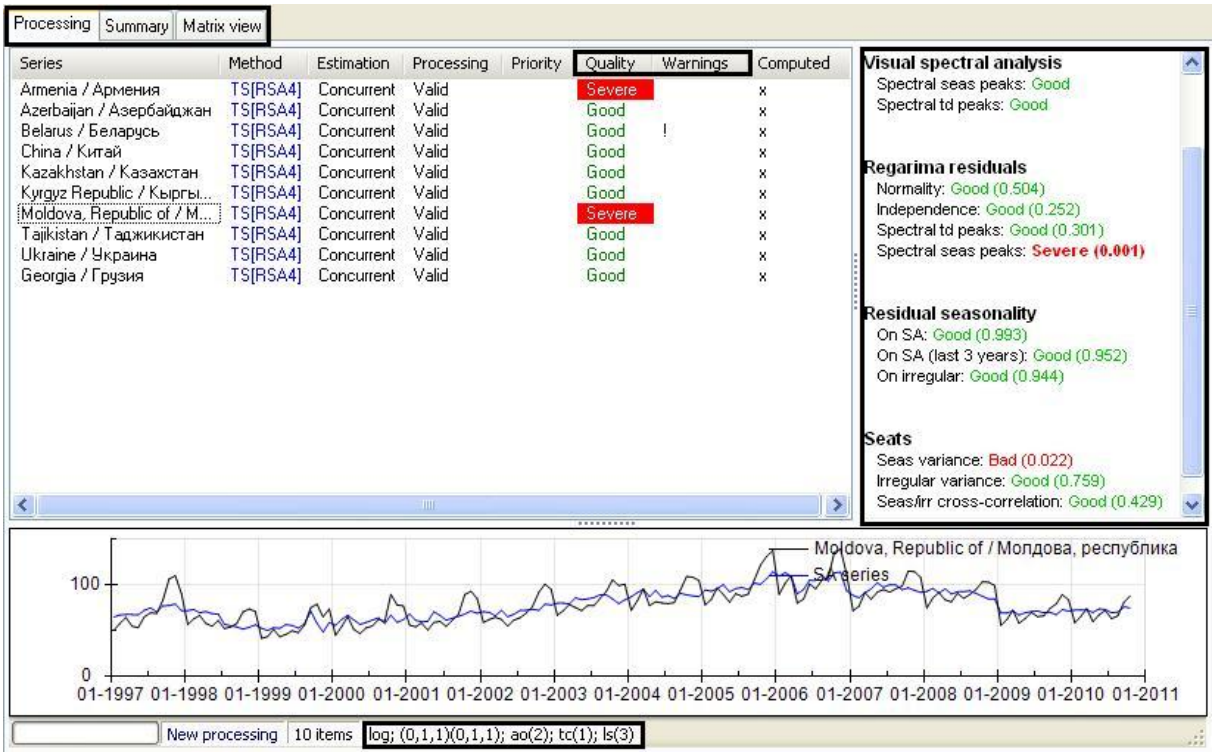


Image 30. Informative parts of multi-processing window

If it appears that the quality of a specific processing is insufficient (Image 30), the user should go to the detailed window and try to modify some options to get a better result.

In the example showed in Image 31 for seasonal adjustment of Moldova, the chosen specification for trading days effects (week days) was not able to remove all the re-occurring effects. The diagnostics indicated "amongst other things", the presence of spectral peaks on the seasonal frequencies and also seasonal variance is quite high. The user can (try to) solve the problem as follows:

- Change the trading day specification
  - Trading days changed to td1 (working day)
  - “pretest” changed to false to impose it
- Apply the new specification (top-left button)
- When the result is acceptable, save it to the multi-processing window ("Save" button); the multi-processing contains now the adjusted specification for that series.

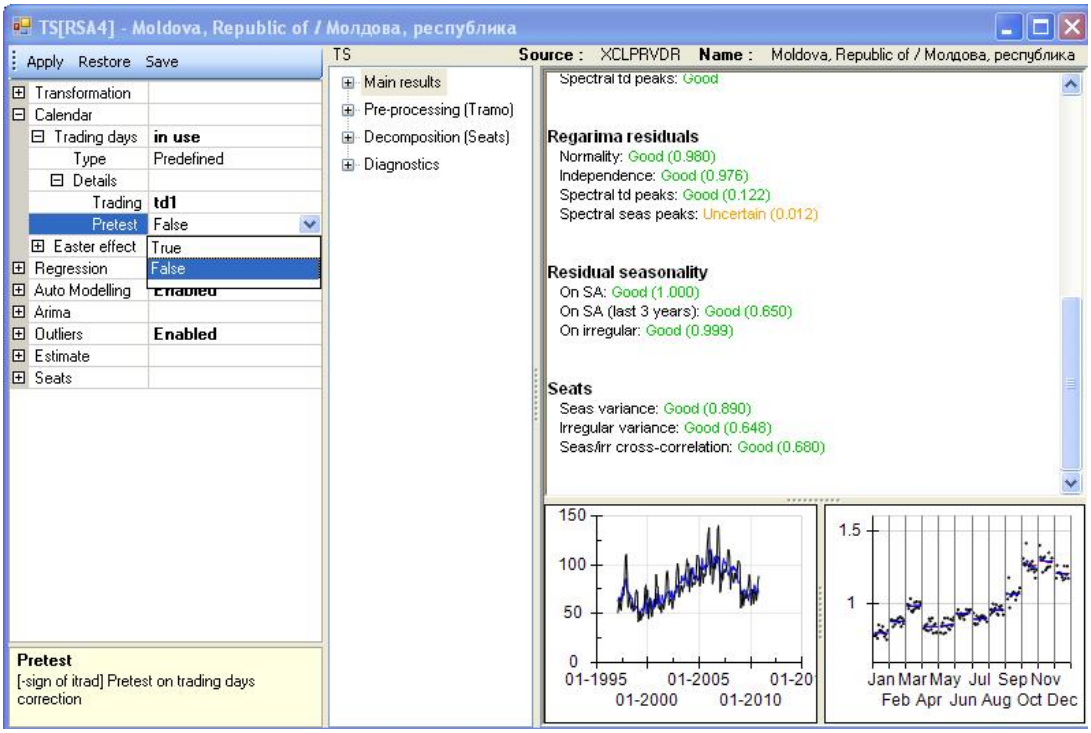


Image 31. Modification of specification in multi-process

The user can sort the multi-processing by clicking on a column header. Sorting the "Quality" can be helpful when the processing contains many series. Demetra+ also provides other views of the multi-processing. The "Summary" panel gives general information on the model used by each method for each frequency (Image 32).

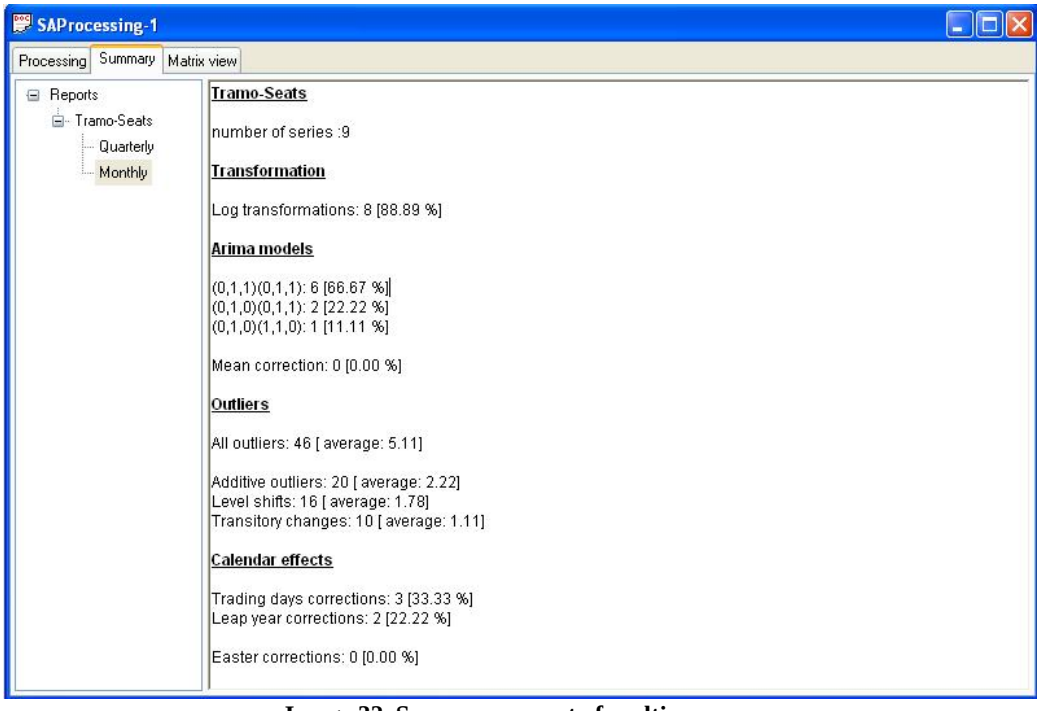
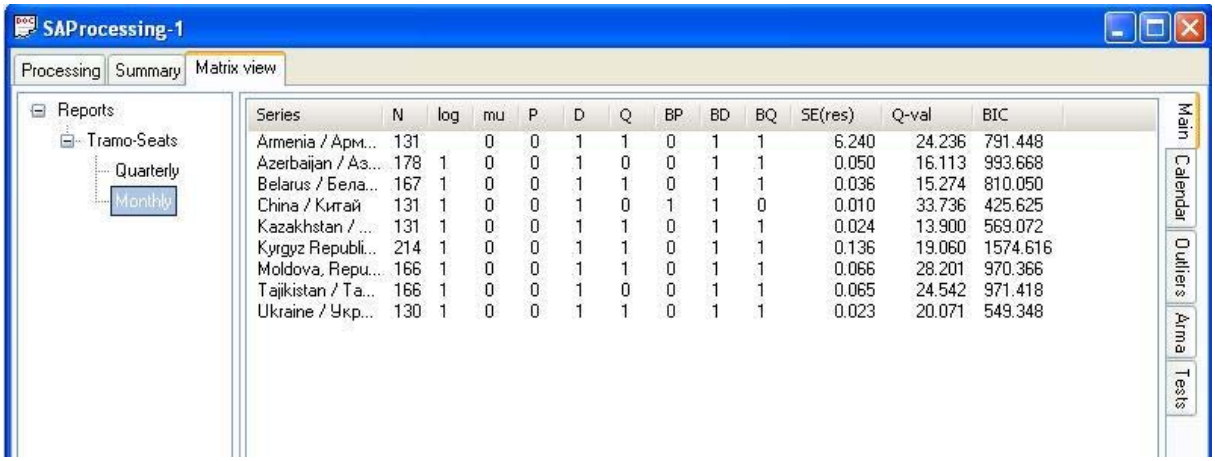


Image 32. Summary report of multi-process

For the analysis of EECCA countries' industrial production indexes performed here, TRAMO&SEATS is used for all series (monthly and quarterly) in the multi-processing. The monthly time series are defined mostly in AIRLINE model (66.7%). Number of outliers per series is 5.11 (≈5) in TRAMO&SEATS.

TRAMO&SEATS detected trading day effect in 33.33%, but not Easter effect in 9 of the monthly series. According to these results, it may be suggested that there are not significant calendar effects (working days and Easter effect) in the EECCA countries' industrial production series. But, this may cause deterioration on the well determined seasonality. So, they may have still calendar effects. And, given the volatile structure of some of the EECCA economies, the number of outliers per series may be regarded as normal.

In the Image 33, the "Matrix view" panel provides information similar to the matrix output of TSW (Tramo&Seats for Windows). It contains summary information by each series about main statistical properties of the ARIMA model used in "Pre-processing", calendar specification results, outlier structure of each series and coefficients of ARIMA model and their significance levels. A table with the p-values of different tests computed on the residuals and with other information (annual discrepancies between raw and adjusted data, spectral visual peaks) is finally provided. The matrices can be copied into the clipboard by the usual keys combination (Ctrl+C), for user in other software, like Excel. Finally, it should be noted that the details of a processing can be displayed from that output by a double click on the name of a series.



Series	N	log	mu	P	D	Q	BP	BD	BQ	SE(res)	Q-val	BIC
Armenia / Арм...	131		0	0	1	1	0	1	1	6.240	24.236	791.448
Azerbaijan / Аз...	178	1	0	0	1	0	0	1	1	0.050	16.113	993.668
Belarus / Бела...	167	1	0	0	1	1	0	1	1	0.036	15.274	810.050
China / Китай	131	1	0	0	1	0	1	1	0	0.010	33.736	425.625
Kazakhstan / ...	131	1	0	0	1	1	0	1	1	0.024	13.900	569.072
Kyrgyz Republi...	214	1	0	0	1	1	0	1	1	0.136	19.060	1574.616
Moldova, Repu...	166	1	0	0	1	1	0	1	1	0.066	28.201	970.366
Tajikistan / Та...	166	1	0	0	1	0	0	1	1	0.065	24.542	971.418
Ukraine / Укр...	130	1	0	0	1	1	0	1	1	0.023	20.071	549.348

Image 33. Matrix view of Demetra+

5.2.3. Exporting the results

For multi processing, Demetra+ is able to export the outputs of multi-process into different formats i.e. *.txt, *.xls, ODBC or *.csv . To manage it, "Generate output" button is available under the SAProcessing-1 tab (Image 34), provided that the multi-processing has been computed. The

user can select the format that he wants to generate and he can define some options for each of them (Image 35). Most of the results displayed by Demetra+ can be copied (by means of local menus or by means of the Ctrl+C key combination) or dragged/dropped to other software.

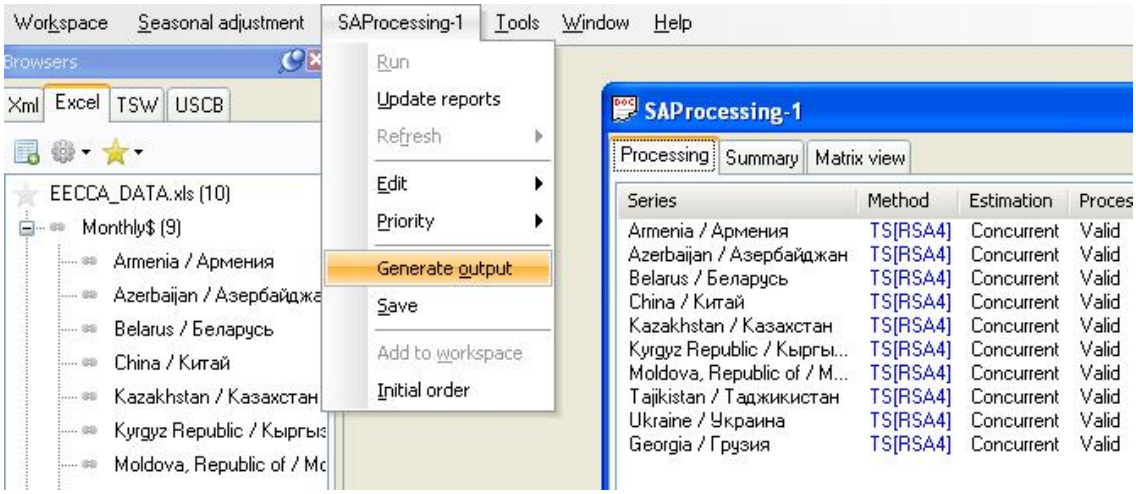


Image 34. Generating output

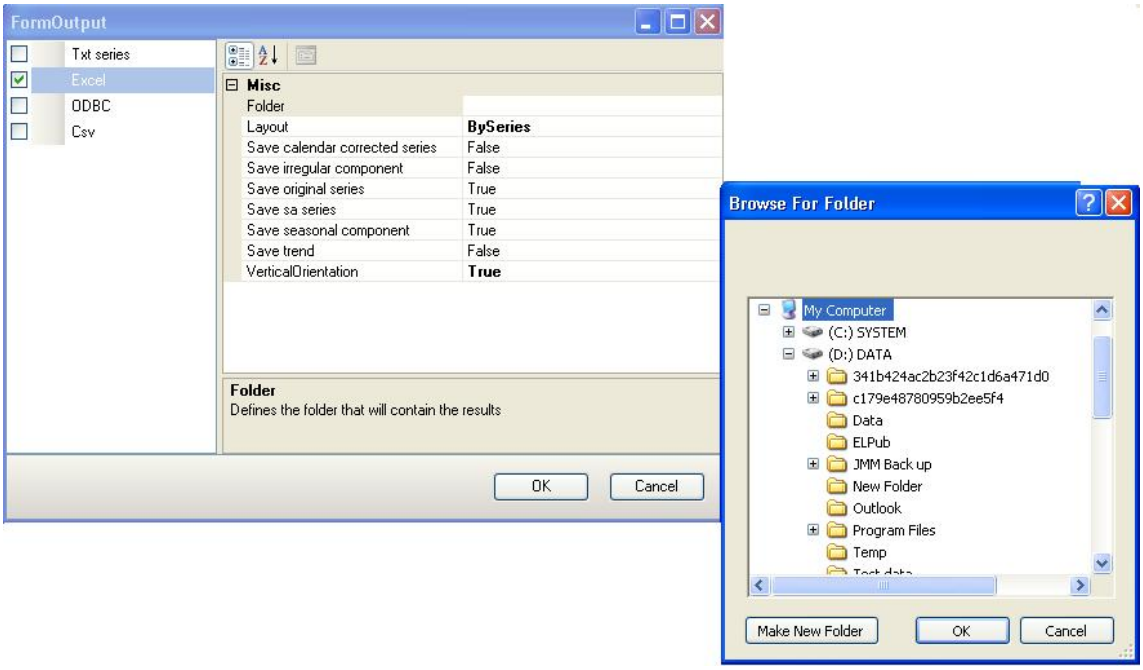


Image 35. Steps of the generating output

5.2.4. Revision of a multi-processing

If a user wishes to be able to refresh a processing with new data, he must follow the next rules:

- The series must come from a browser; series imported by drag/drop or by the clipboard cannot be refreshed because Demetra+ is not able to register their origin.

- Information used to identify a data cannot be changed (path of the file, names of sheets, series, identifiers in a database...) cannot be modified (of course).
- The multi-processing must be added to a workspace and save with that workspace
- If some processing contains user-defined regression variables or calendars (a topic not discussed here), they must be updated.

This short document is not aimed at presenting all the details underlying the revision of a processing. It will only give, for our concrete example, the different steps to create and to revise such a processing. Creation of the document may be explained as below:

1. Create an Excel workbook with the current series
2. Save it in a specific place (i.e. My Documents),
3. Perform the multi-processing as explained above, using the Excel browser to launch the data.
4. Add the multi-processing (called SAProcessing-1) to “Workspace”
5. Save or (save as) the “Workspace” to a place in computer (Image 36),

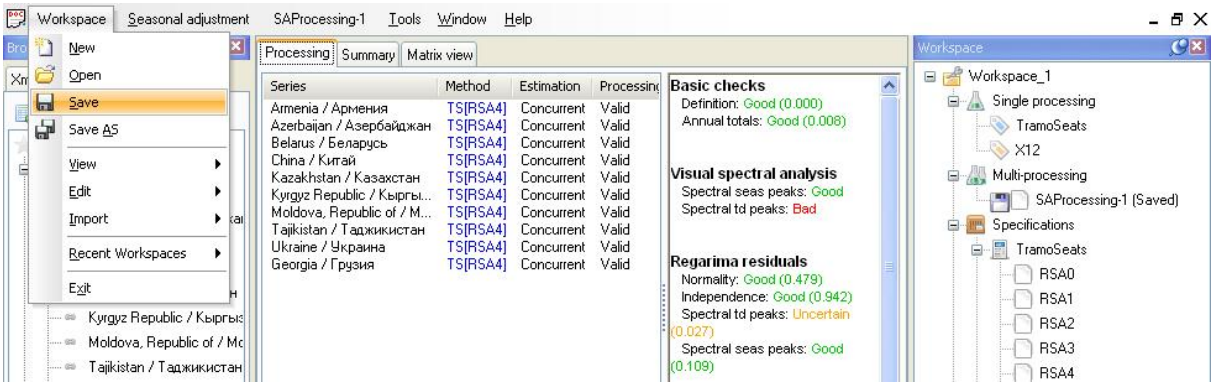


Image 36. Saving the workspace for future works

Refreshing of the processing (Image 37);

1. Update the data file with the new data (do not change the place of data file in the computer)
2. Open the previous “Workspace” in Demetra+; by default, the last saved workspace is open at the start of Demetra+.
3. Double click the "SAProcessing-1" under the "Multi-processing" node of the “Workspace”
4. Find the “Refresh” item under the "SAProcessing-1" item in the main menu.
5. Choose refreshing strategy and click on it.

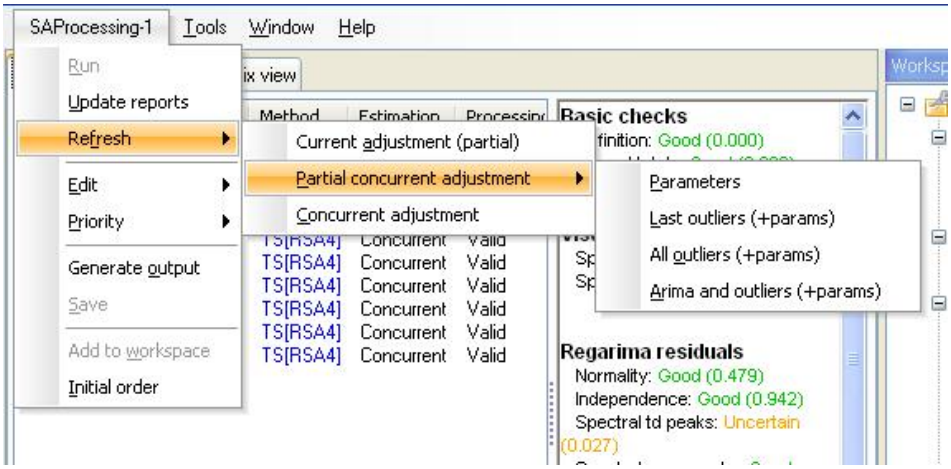


Image 37. Refreshment strategies

Current adjustment (partial) completely fixed your specifications exception with user-regression or calendar parameters. Partial concurrent adjustment is divided into four options. If you select the option "Parameters", Demetra+ will fix the model (ARIMA specification, position of the outliers, specification of the calendar effects...), but all the coefficients will be re-estimated. The second option (Outliers + params) process the same way, except that it will re-estimate the outliers. The third option (ARIMA and outliers +params) add the revision of the Arima model to the previous option. The fourth option (Complete model) will make a complete estimation (using the specification chosen at the creation of the multi-processing). The last is concurrent adjustment as explained in ESS Guidelines, all specification are performed again without any restrictions (by means of fixing). After selecting the refresh strategy, refreshment is performed, immediately. The strategies may be summarized in Table 5.

Table 5. Summary of refreshment strategies

		Outlier specification		ARIMA specification (p,d,q)(P,D,Q)		Calendar Effects (Trading and working day, and Easter Effect)
		Position	Parameters	Orders	Parameters	Parameters
Current adjustment (partial)		Fixed	Free	Fixed	Fixed	Fixed
Partial Concurrent Adjustment	Parameters	Fixed	Free	Fixed	Free	Free
	Last Outliers (+params)	Just last outlier is free	Free	Fixed	Free	Free
	All outliers (+params)	Free	Free	Fixed	Free	Free
	Arima and Outliers (+params)	Free	Free	Free	Free	Free
Concurrent Adjustment		Free	Free	Free	Free	Free

6. Conclusion

This document aims to offer basic instructions for performing seasonal adjustment with Demetra+ software. The paper is prepared using available economic statistics of the Eastern European, Caucasus and Central Asian countries as examples. Monthly industrial production indices are the indicator used mainly in the paper. The paper includes an overview of the different parts of Demetra+ software, and it explains the whole process of seasonal adjustment. In other words, it explains how to load data into Demetra+, demonstrates the graphical capabilities of the software, and introduces the alternative processing methods using real data examples.