CENTRAL BANK OF THE REPUBLIC OF TURKEY

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Seasonal Adjustment Methods: An Application to the Turkish Monetary Aggregates

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Abstract

Seasonality can be defined as a pattern of a time series, which repeats at regular intervals every year. Seasonal fluctuations in data make it difficult to analyse whether changes in data for a given period reflect important increases or decreases in the level of the data, or are due to regularly occurring variation. In search for the economic measures that are independent of seasonal variations, methods had been developed to remove the effect of seasonal changes from the original data to produce seasonally adjusted data. The seasonally adjusted data, providing more readily interpretable measures of changes occurring in a given period, reflects real economic movements without the misleading seasonal changes.

The choice of method for seasonal adjustment is crucial for the removal of all seasonal effects in the data. Seasonal adjustment is normally done using the off-the-shelf programs-most commonly worldwide by one of the programs in the X-11 family, X-12 ARIMA, the latest improved version. Another program in common use is the TRAMO/SEATS package developed by the Bank of Spain and promoted by Eurostat. In this study, the performances of two seasonal adjustment methods, X-12 ARIMA and TRAMO/SEATS, on the monetary aggregates will be studied. In section five, the two methods are applied to the M2 monetary aggregate series, and the resulting seasonally adjusted series are compared using specific criteria. In sections six and seven, some of the issues that should be concerned in the process of seasonal adjustment, are discussed.

Key Words: Seasonal Adjustment, TRAMO/SEATS, X-12 ARIMA

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CONTENTS:

1. Introduction

The fluctuations seen in a time series can be classified as repeatable or non-repeatable. Seasonality can be defined as a pattern of a time series, which repeats at regular intervals every year. In evaluating whether the economy or particular aspects of the economy are in growth or decline, predicting business cycles or understanding how far along the economy is in a business cycle is a fundamental task. Seasonally adjusted data, providing more interpretable measures of changes occurring in a given period, reflects real economic movements without the misleading seasonal changes. A time series from which the seasonal movements have been eliminated allows the comparison of data between two months or quarters for which the seasonal pattern is different. Also seasonal effects on non-adjusted or original data make it difficult to derive valid comparisons over time using these data, particularly for the most recent period. Consequently, seasonally adjusted data are always used in economic modeling and cyclical analysis. Presentation of data on a seasonally adjusted basis allows the comparison of the evolution of different series, which have different seasonal patterns, and is particularly pertinent in the context of international comparisons since countries may be in different seasons at identical periods of the year. Seasonal adjustment allows one to determine medium/long term movements in data, upon which management decisions may be based, by removing the short term seasonal fluctuations. The improvement in the theory of seasonal adjustment enables to draw more reliable inferences about economic activities.

Developed by the U.S. Bureau of the Census, the X-12 ARIMA seasonal adjustment method, which is commonly in use by many institutions, is the latest version of the methods that use moving average filters. The other commonly used seasonal adjustment method is the TRAMO/SEATS ("Time Series Regression with ARIMA noise, Missing Observations and Outliers" / "Signal Extraction in ARIMA Time Series"), which is a model-based seasonal adjustment method.

The purpose of this paper is to discuss the performances of two seasonal adjustment methods, X-12 ARIMA and TRAMO/SEATS, on the Turkish monetary aggregates. Initially, with the short history of seasonal adjustment methods, a brief description of the two methods, X-12 ARIMA (X12A) and TRAMO/SEATS (T/S), is given. In section three, the monetary aggregate data are described. In section four, the calendar effects of the Turkish monetary aggregates are examined. In the fifth section, these two methods are applied to the monetary aggregate M2 and the seasonally adjusted figures are compared. Also the performance of the two methods on white noise process containing spurious seasonality is given. Also in section five, the two methods are applied iteratively to the monetary aggregates series M1, M2, M2X and M3 to monitor their revision structures. On the remaining part of the study, the T/S method is used. An issue that must be considered in detailed seasonal adjustment process is the selection of direct or indirect adjustment technique. The comparison of the two adjustment techniques with the T/S method on monetary aggregates is presented in section six. In section seven, concurrent and factor projected adjustment techniques are discussed. In the conclusion section, a brief summary of the findings is listed.

2. Developments in Seasonal Adjustment Methods

The simplest known ad-hoc seasonal adjustment method decomposes the time series into four components using moving averages. The four components are, trend (T), irregular (I), cyclical (C) and seasonal (S) components.

Census X-11 method, developed by the U.S. Bureau of the Census in 1965, is an ad-hoc seasonal adjustment method that uses Henderson moving average algorithm (Hylleberg, 1988). Although the method is still used in current practice, it has significant drawbacks that lead to search for new methodologies. First of all, the method is not based on a statistical model. The ad-hoc methods generally known as the moving average methods assumes that every series can be decomposed to four components mentioned above using the same procedure. The moving average filtering procedure implicitly assumes that all effects except the seasonal effect narrowly defined are approximately symmetrically distributed around their expected value and thus can be fully eliminated by using the centered moving average filter. Ideally all effects that are not approximately symmetrically distributed around the expected value should have been removed. Besides these restrictive assumptions, the practical problems encountered seem to be more serious. Since the method is based on moving average principle, a loss of observations on both ends of the series causes the seasonal effect to be underestimated. Also the adjusted series can portray a structural change that has not occurred. Last of all, if the Census X-11 method is applied to the economic series containing stochastic seasonality, the seasonal effect cannot be totally removed (Planas, 1997a).

Under the supervision of E.B. Dagum, X-11 ARIMA method was developed by the Statistics Canada in 1978. The filters used in ad-hoc methods such as the Census X-11 are asymmetric. Henderson moving average filters can be given as example to such ad-hoc filters. Thus with such filters, the adjusted series vary significantly if a new observation is added to the series. The X-11 ARIMA method uses less asymmetric filters to overcome this problem, providing the adjusted series to be more robust. For this purpose, with formed Box Jenkins ARIMA models, the series are extended with forecasts and backcasts. The X-11 ARIMA method was improved by the U.S. Bureau of the Census to the X-12 ARIMA method which basically uses the X-11 ARIMA procedure but with some important changes. The main change is the additional pre-treatment for the data. The pre-program for X-12 ARIMA is called REGARIMA and can mainly detect and correct for different types of outliers and estimate a calendar component. The series adjusted for such effects are extended by forecasts and backcasts with ARIMA models to avoid loss of data when using moving average filters. REGARIMA selects the appropriate ARIMA model to the preadjusted series according to the criteria given below:

1- The average percentage standard error within sample forecasts over the last year (should not exceed 15 percent).

2- Significance of Ljung Box Q statistics, testing autocorrelation of residuals (should not be significant at 5 percent level).

3- The test for user defined periodic or seasonal over differencing.

The candidate model is rejected if it does not satisfy any of the above three criteria. If all the candidate models are rejected, the normal X-11 procedure is used. The most complex model that the X-12 ARIMA method tests in Box-Jenkins seasonal ARIMA representation is $(2,1,2)(0,1,1)_s$.

The other approach in seasonal adjustment is seasonal adjustment by signal extraction, developed by Burman (1980). This approach is based on optimal filtering which is derived from a time series model of the ARIMA type describing the behavior of the series while the components are explicitly specified. It is generally known as the ARIMA-Model-Based (AMB) approach to unobserved components analyses (Planas, 1997b). TRAMO/SEATS method, developed by Gomez and Maravall, is an AMB method. Its pre-program TRAMO is similar to REGARIMA. The major difference between the two pre-programs is seen on the ARIMA model selection criteria. TRAMO initially models the series with AR(1) and ARMA(1,1) to determine the periodic and seasonal difference levels. The appropriate seasonal or non-seasonal ARMA model is selected according to BIC criterion, where the most complex ARIMA model that TRAMO tests is ARIMA (3,2,3) $(1,1,1)_s$.

TRAMO also automatically identifies outliers and calculates other regression variables such as trading days or Easter variables. Then, TRAMO passes the linearized series to SEATS, where the actual decomposition is done. In SEATS, first the spectral density function of the estimated model is decomposed into the spectral density function of the unobserved components, which are assumed to be orthogonal. SEATS then estimates the parameters of the two components (trend-cycle and seasonally adjusted component). Since the Wiener-Kolmogorov filter is used, the observed series have to be forecasted and backcasted (Fischer, 1995).

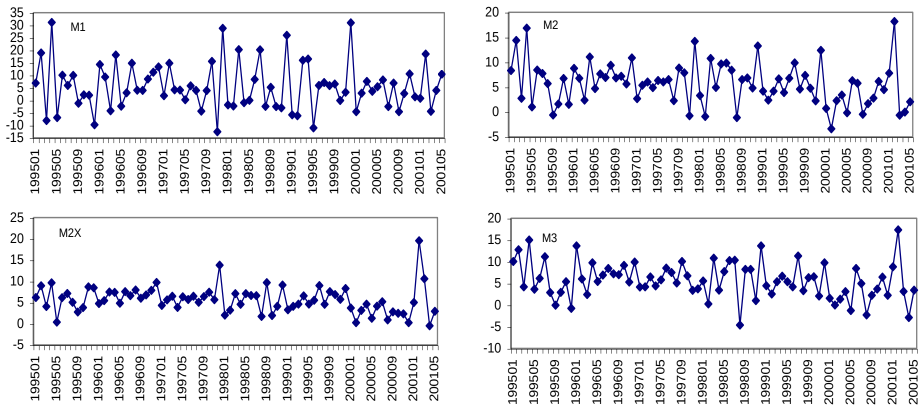
The seasonally adjusted figures of the data using the two techniques, namely the T/S and the X12A, differ mainly on the grounds of the following issues: First of all the pre-adjustment programs are completely different. That is the TRAMO of the T/S uses seasonal adjustment filters based on statistical decisions whereas the REGARIMA of the X12A uses the ad-hoc seasonal adjustment filters. Besides, the outlier detection of the two pre-programs is different in a sense that the TRAMO automatically detects a different type of outlier called temporary change in addition to the other commonly detected outliers, level shift and additive outliers. For example, both the T/S and the X12A detect outliers at 1994 (March, April, June) and 2001 (February) in Turkish data. However, the outliers at March 1994 and February 2001 are identified as temporary change by the T/S whereas they are identified as additive outliers by the X12A. This differentiation of the two programs in identifying outliers results in different seasonally adjusted series.

TRAMO in general possesses more flexible pre-adjustment options for an automatic running. It provides a test for multiplicative or additive decomposition and a complete automatic model identification. This is advantageous especially for large-scale seasonal adjustment (Dosse and Planas, 1996).

3. Monetary Aggregates: Data Description

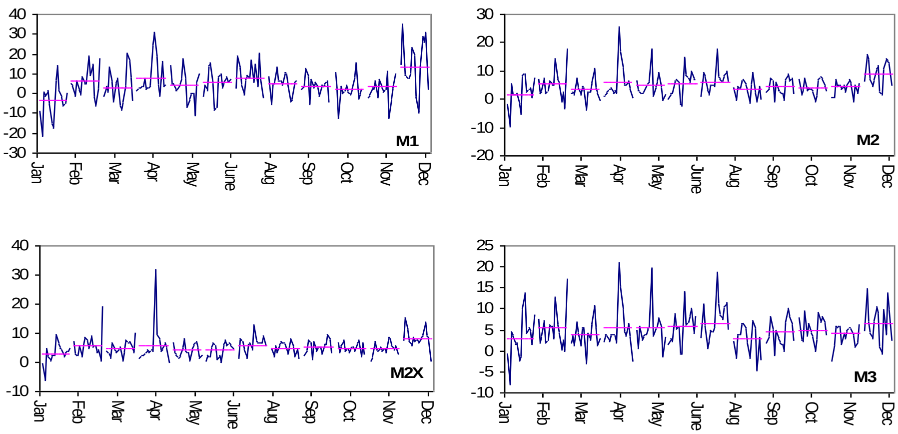
The monetary aggregates under study are M1, M2, M2X and M3. M1 is composed of currency in circulation plus demand deposits whereas broader money M2 is constituted of M1 plus time deposits in domestic currency. M2X is defined to be M2 plus deposits denominated by foreign currencies. Finally M3 is defined to be the sum of M2, official deposits and other deposits with Central Bank of the Republic of Turkey (CBRT). For the analysis, the end of period data, which is obtained from the CBRT Weekly Bulletin, are used between the time intervals of December 1985 and May 2001.

Fig. 1. Monetary Aggregates (% Change)



The seasonal nature of the monetary aggregates can be seen in the stacked line plot below. The stacked view reorders the series into seasonal groups where the first season observations are ordered by year, and then followed by the second season observations, and so on. Also depicted in Figure 2, are the horizontal lines identifying the mean of the series in each season. As can be seen, all of the series under study reach their maximum value in December, and are at minimum in January. A slight increase in the values can be depicted in the month July.

Fig. 2. Stacked Line Plots of Monetary Aggregates



The rearrangement of the balance sheets of the banking sector in December causes seasonal movements in the demand and time deposits that constitute the main determinants of seasonality in the monetary aggregates. The currency in circulation sub-component has more volatility than seasonality.

4. Preadjustment (Calendar Effects)

Variations in the number of working and trading days and the weekday composition in each period, as well as the timing of moving holidays can have significant impacts on the series.

4.1. Trading Day and Working Day Effect

The varying number of weekdays influences the economic time series in each month. That is for example the number of Mondays in March 2001 is 4, whereas the same is 5 in the upcoming month, April. Taking this effect into account, the trading day adjustment also assumes no economical activity on Sundays. For this purpose six regression variables for the remaining weekdays are used to adjust for such effect. Most real sector series are influenced by the trading day effect.

Unlike the trading day, working day adjustment assumes no difference in the economical activity between the working days, but between these and non-working days (Saturday, Sunday). Hence the varying number of these days is considered. Most financial sector series are influenced by the working day effect. In addition to the above-mentioned effects, the adjustment of calendar effects should include the leap year effect. The adjustment of their effect is done with an additional regression variable (Dosse and Planas, 1996). The pre-programs TRAMO and REGARIMA create the corresponding regression variables describing the working day, leap year and moving holiday effects and then introduce these effects into the model. For monetary aggregates, the mentioned effects are examined and the results are given in Table 1.

Working day effect is found to be significant at 5 percent level only in M1 series. The leap year effect is insignificant in all of the series studied.

Table 1

	Working Day Effect (t-stat)	Leap Year Effect (t-stat)	Moving Holiday Effect (t-stat)
M1	2,00**	-0,13	-1,50
M2	-1,24	0,16	-3,05**
M2X	-1,25	-0,79	-2,62**
M3	0,11	1,45	1,01

4.2. Holiday Effect

Holiday effect can be examined through two headings:

- Specific holidays, official holidays occurring at fixed dates;
- Moving holidays, occurring at changing intervals.

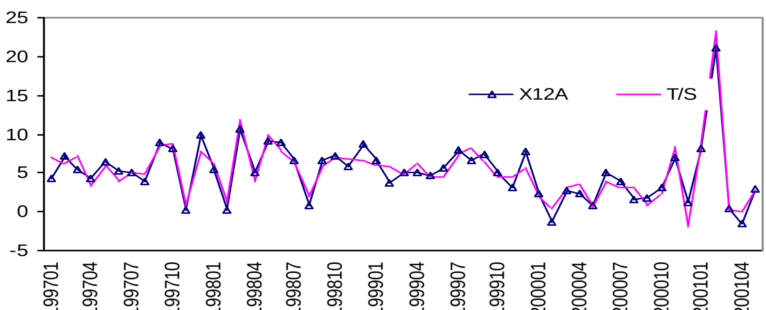
The specific holidays for Turkey include five official holidays. In the series examined, no such effect is found to be statistically significant. The religious holidays (Sacrifice Holiday and Ramadan) constitute the moving holidays. This type of effect is adjusted by a formed regression variable. If a month contains any religious holidays, the regression variable is the number of days of that holiday and zero otherwise. If the religious holiday occurs on non-working days (Saturday and Sunday for monetary aggregates), then the regression variable is modified by subtracting the corresponding non-working days from the number of religious holidays for that particular month. Doing so will avoid the double adjustment of the non-working days. For example if the three-day long Ramadan holiday starts on Thursday, then the regression variable is two for that month since the third day of the holiday is on Saturday. The moving holiday effect is found to be significant at 5 percent level in the M2 and M2X series.

5. Empirical Results

5.1. Comparison of T/S and X12A on Monetary Aggregate M2

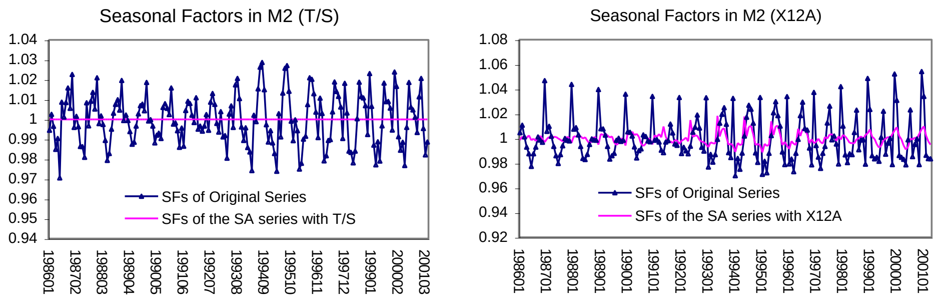
One issue concerning the interpretation of the economic data is to determine the underlying growth or decline pattern presented. Since most of the monetary aggregates portray significant seasonality, the seasonally adjusted figures play an important role on the interpretation of real changes. In this application, as an illustrative example, the monetary aggregate M2 is seasonally adjusted using the two X12A and T/S methods and the resulting series are compared. The percent change figures of seasonally adjusted M2 series using two methods are given below. The graph depicts the differentiation of the two methods.

Fig. 3. Comparison of T/S and X12A on Monetary Aggregate M2 (% Change)



One of the "objective" criteria in the comparison of seasonal adjustment methods is idempotency, i.e., a seasonal adjustment method applied to the seasonally adjusted (SA) series should leave the SA series unchanged (Maravall, 1997). The unchanged SA series should have a constant seasonal factor of 1. The seasonal factors of the original, and the seasonally adjusted series of M2 for both methods are given below in Graph 4.

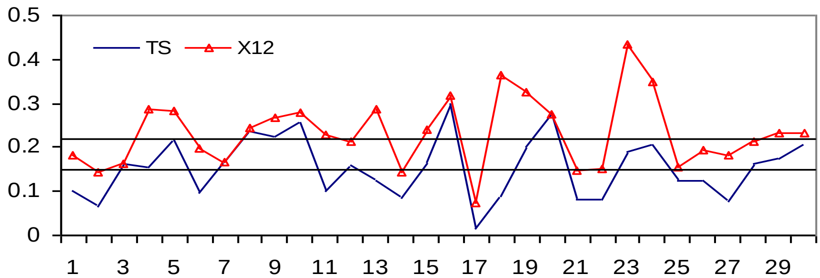
Fig. 4. Seasonal Factors of M2



As can be seen above, the T/S method finds seasonal factors of constant 1 to the adjusted series whereas the X12A method still detects seasonal factors different from 1 meaning a detection of seasonality in the seasonally adjusted data. This idempotency criterion depicts a significant difference between the two methods.

The other "objective" criterion that Maravall points out is that, when applied to a white noise process, the methods should produce no spurious seasonality. Thirty white noise N(0,1) series are randomly generated for this purpose. The variances and the variance means of the seasonal factors of the X12A method are found to be greater than that of the T/S method.

Fig. 5. Variances of Seasonal Components



As shown above, the variance means of the seasonal factors of the two methods X12A and T/S, are found to be 0,233 and 0,158 respectively.

5.2. The Comparison of Revisions on Monetary Aggregates Produced by T/S and X12A Methods

The moving average filter that X12A uses, and the Wiener-Kolmogorov filter that T/S uses are symmetric filters. For sufficiently large samples, the application of the filters around the central periods yields the "final estimator" of preliminary estimator. Final estimators do not change when a new observation is added to the series and seasonal adjustment process is reapplied. Optimal preliminary estimators can be obtained by the replacement of future observations by their forecasts. Forecasts are updated and replaced by the observed values as new observations become available, known as revisions. The size of the revision errors plays an important role on the robustness of the seasonal adjustment methods. In this application, revisions obtained from the two filters of the two methods are compared on the monetary aggregates.

When the series (x_t) assumed to be composed of seasonal (s_t) and nonseasonal (n_t) components, the series x_t can be given by:

$$x_t = s_t + n_t \tag{1}$$

where a log transformation may be needed for additivity. The nonseasonal component (n_t) can be further defined as the sum of its two subcomponents, trend (p_t) and irregular (u_t) components. The final estimator of the seasonal component is given by:

$$\hat{s}_t = \nu_s(B) x_t \tag{2}$$

where $\nu_s(B)$ is a symmetric filter and can be written as $\nu_s(B) = \ldots + \nu_{-1}(B) + \nu_0 + \nu_1(F) + \ldots$.. $\nu_s(B)$ corresponds to Wiener-Kolmogorov filter in SEATS, and one of the named 3 by 3, 3 by 5 or 3 by 9 seasonal MA filters in the X12A. The correlation structure of the series x_t may be defined by the model:

$$x_t = a_t + \psi_1 a_{t-1} + \ldots = \psi(B) a_t \tag{3}$$

where a_t denotes a normal variable and ψ(B) denotes a polynomial which can be infinite. Inserting (3) into (2) yields the final estimator of s_t:

$$\hat{s}_t = \nu_s(B)\psi(B)a_t = \xi_s(B)a_t \tag{4}$$

where $\xi_s(B) = \nu_s(B)\psi(B) = ... + \xi_{s-1}(B) + \xi_{s0} + \xi_{s1}F + ...$ A preliminary estimate $\hat{s}_{t/t+k}$ of s_t obtained at time t+k is simply obtained by taking the expectation of the final estimator s_t conditional on the information available at time t+k:

$$\begin{aligned}\hat{s}_{t/t+k} &= E_{t+k}\left[\xi_s(B)a_t\right] \\ &= E_{t+k}\left[... + \xi_{s-1}B + \xi_{s0} + \xi_{s1}F + ... + \xi_{sk}F^k + \xi_{sk+1}F^{k+1} + ...\right]a_t \\ &= \left[.. + \xi_{s-1}B + \xi_{s0} + \xi_{s1}F + ... + \xi_{sk}F^k\right].a_t \\ &= \xi_s^k(B)a_t\end{aligned}$$

The revision R_k in the preliminary estimate of s_t obtained at time t+k is:

$$R_k = \hat{s}_t - \hat{s}_{t/t+k} = \sum_{i=k+1}^{\infty}\xi_{si}a_{t+i} \tag{5}$$

The update in the revisions after one further observation is as follows:

$$r_k = \hat{s}_{t/t+k+1} - \hat{s}_{t/t+k} = \xi_{sk+1}a_{t+k+1} \quad \text{, k=0,…, T-1}$$

where T denotes the number of seasonal adjustment process.

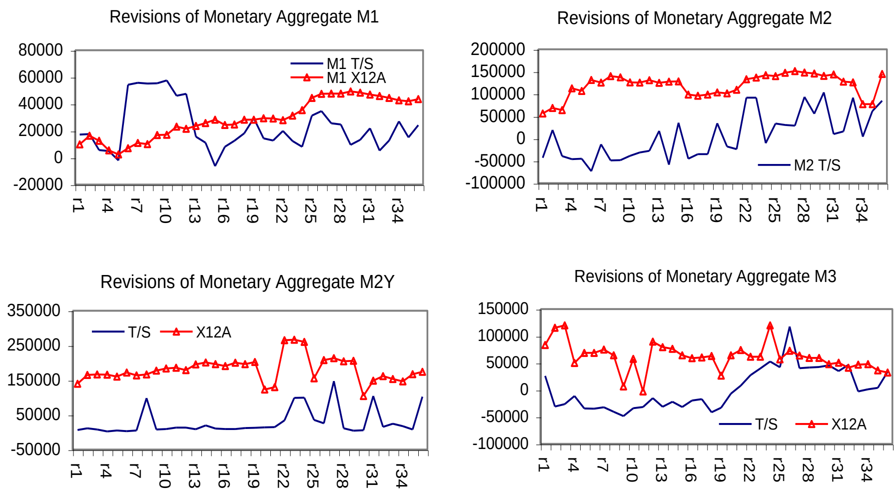
The revision patterns differ with different filters. Revisions obtained from different filters can be compared by the sum of squared residuals (SQR) statistic. The SQR statistic is defined to be (Dosse, Planas, 1996) :

$$SQR = \frac{\sum_{k=0}^{T-1} r_k^{\;2}}{\hat{s}_{t/t+36}^{\;2}} .100^2\% \qquad (6)$$

To examine the revision patterns of the Wiener-Kolmogorov filter used in the T/S method and moving average filter used in the X12A, SQR statistics are calculated for four monetary aggregate series. Starting at April 1998, seasonal adjustment process is carried out thirty six times as each additional observation is included to the model. Thus the revisions are calculated according to the reference date of April 1998.

In the graphs below, the revision patterns of the each series are given. As can be seen almost all the revisions obtained from the T/S are smaller than those obtained from the X12A.

Fig. 6. Revisions of Monetary Aggregates



Finally in the table below, the SQR statistics for each series are given. For all the four monetary aggregate series, the SQRs obtained from the T/S are found to be smaller than those obtained from the X12A.

Table 2

	SQR	
	T/S	**X12A**
M1	102.7	130.6
M2	19.1	113.6
M2X	4.1	70.6
M3	9.3	29.6

6. Direct and Indirect Adjustment

For economic analysis purposes, it may be necessary to compile time series through the aggregation of subcomponents. In seasonal adjustment, the direct approach refers to the adjustment of aggregated raw components and the indirect approach is the aggregation of seasonally adjusted components.

Although no conclusive theoretical research has been done, some criteria to discriminate between the direct and the indirect approaches have been put forward as:

- Stochastic properties of the components must be examined. The indirect approach should be used if the components portray different stochastic properties.
- Indirect approach should be utilised if the data sources of the components are different.
- If the components convey different working / trading day effects, using of the indirect approach is appropriate again.
- If there exists high correlation between the components, the direct approach in seasonal adjustment should be used.

Not all of the above stated criteria favor one of the approaches all the time. For four monetary aggregates, the seasonally adjusted series with the direct and the indirect approaches are presented in the table below. The above stated criteria should be considered in the selection of the appropriate approach.

Table 3: Direct and Indirect Adjustment in Monetary Aggregates (in trillion TL)

	M1		M2		M2X		M3	
	Direct	**Indirect**	**Direct**	**Indirect**	**Direct**	**Indirect**	**Direct**	**Indirect**
Jan.00	4856.92	4757.25	22440.97	22802.72	40557.37	41324.14	23870.48	23912.02
Feb.00	4908.73	4927.21	22352.59	21863.59	41843.38	41234.83	23829.70	23646.37
Mar.00	5317.27	4983.60	22857.31	22366.23	43217.50	42562.06	24228.22	23967.03
Apr.00	5353.19	5239.81	23266.15	23051.32	44678.61	44496.96	24900.01	24707.87
May.00	5677.00	5485.82	23728.63	23014.37	46117.16	45613.41	24582.65	24488.94
June.00	6135.74	6013.55	24476.31	24572.46	47707.85	47893.47	26656.39	26511.32
July.00	5878.75	5995.93	25541.25	26060.71	49252.73	50310.49	27980.71	27705.64
Aug.00	6182.12	6186.20	25840.80	25758.66	50514.90	50573.75	27343.38	27283.30
Sep.00	6056.58	6185.88	26415.47	26469.80	51741.82	52046.79	27954.91	28155.05
Oct.00	6271.75	6434.02	27320.43	27297.10	52972.48	53227.39	28984.66	28909.31
Nov.00	7116.68	7326.98	28823.82	29223.76	54169.14	54780.02	30855.62	31182.48
Dec.00	6919.71	7243.63	29934.74	30395.53	55283.85	54070.11	31705.02	32196.58

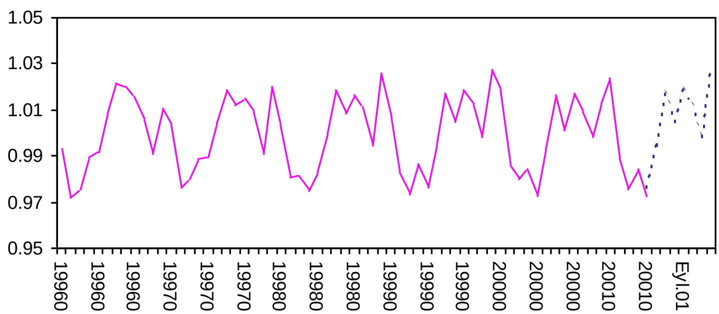
For the series examined where the components have different working day effect patterns, and are collected from different data sources, the indirect approach seems appropriate. However, since the monetary aggregate series are contaminated with dominating trends, the correlation between the components are high, favoring the direct approach. As a result, different criteria can lead to different approaches. Therefore the choice is left to the experiences of the analyst most of the time.

7. Concurrent and Factor Projected Adjustment

This is another important issue that must be considered in seasonal adjustment. The revision of seasonal factor estimation can be carried out either as soon as a new observation becomes available (concurrent adjustment) or seasonal factors can be projected on predetermined longer intervals such as a year (factor projected adjustment).

From a purely theoretical point of view, the use of concurrent adjustment is preferable since new data always contribute new information and should therefore be used. The problem with this argument is that recent data are often not as reliable as historical data as they will undergo a specific revision process. For this reason the factor projected adjustment can be preferred. The factors obtained at the beginning of the year are projected over the entire period. In Graph 7, the projection of seasonal factors of M2 series can be seen. If the original series are modelled multiplicatively, the seasonally adjusted series are obtained by dividing the original series by their seasonal factors. If not, that is the series are modeled additively, the seasonally adjusted series are reached by subtracting the seasonal component from the original series. To use the restrictive factor projected approach, some criteria are put forward (ECB, 2000).

Fig. 7. Seasonal Factor Projection of M2



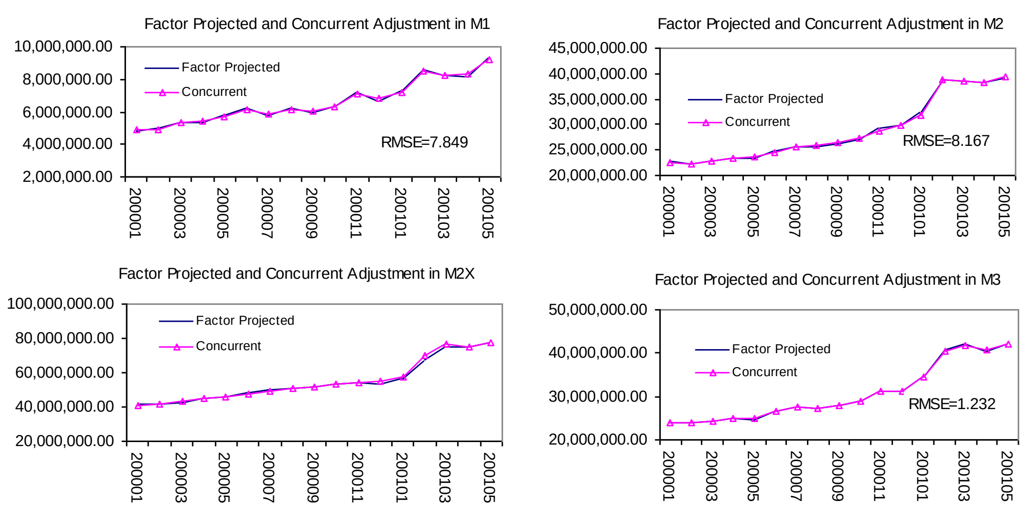
•If the series demonstrate deterministic seasonality, i.e., the seasonal component displaying a constant movement over the time period focused, the seasonal factors can be projected.

•The large size of irregular component leads to large revisions for such a case a factor projected seasonal adjustment can be preferable.

•If the average percentage reduction of the residual mean square error when performing concurrent seasonal adjustment compared to projecting seasonal factors is quite low, then projected adjustment can be chosen again.

The concurrent and projected factor adjustment techniques have been applied to four monetary aggregate series. Since all the series display close-to-deterministic seasonality and the average percentage reductions of the residual mean squared error (RMSE) are low, the two techniques exhibit similar results in the graphs presented in Figure 8. As a result, the factor projected seasonal adjustment is preferable for all the monetary aggregate series studied.

Fig. 8. Factor Projected and Concurrent Adjustment



8. Conclusion

This study focuses on the performances of the two commonly used seasonal adjustment methods, X-12 ARIMA and TRAMO/SEATS, on Turkish monetary aggregates and some critical issues that must be considered in the seasonal adjustment process.

Besides the narrowly defined seasonal effects, trading and working day effects must be included in the seasonal adjustment process. In Turkish monetary aggregate series, the working day effect has been tested and found to be significant only on the M1 series. Further examining of the holiday effects yields no significance of the specific holiday effect in the series studied. Moving holiday effect is found to be present only in the M2 and M2X series (Table 1).

In section five, the X12A and the T/S are applied to the monetary aggregate M2, and the results are compared using specific criteria. The two practical and currently in use methods are found to differ on the adjustment of monetary aggregates. One of the criteria that enable a comparison between the two methods is to test whether the re-adjusted series still conveys seasonal patterns. For this purpose, the seasonally adjusted M2 series are adjusted with the same corresponding method. The T/S method is found to show no seasonality with the seasonal factors equalling one, however the X12A method still detects seasonality with non-zero seasonal factors (Graph 4). The other criterion that is used to compare the two methods is to apply the methods to white noise processes. When applied to the white noise series, the methods should produce no spurious seasonality. The variances and variance means of the seasonal factors of the X12A method is found to be greater than that of the T/S method. As can be seen in Graph 5, the variances of the seasonal factors in all of the white noise series are found to be lower with the T/S method. It can be concluded that, the X12A method does not completely remove all the seasonality from the series and further adjusts series having no significant seasonality.

In the seasonal adjustment process, all of the past and present values of seasonally adjusted series are updated and the forecasts are replaced by the observed values as new observations become available. Small size of the revision errors is important to provide robust seasonal factors. To examine the revision patterns obtained from the two methods, thirty-six revisions of four Turkish monetary aggregates are calculated. For each of the series examined, the revisions from the T/S method are found to be lower and the calculated SQR statistics are found to be smaller with the

T/S method (Table 2). To conclude, the analysis done in the fifth section demonstrate that, the T/S method completely removes seasonal effects from the series and has smaller revisions. For the upcoming sections, the T/S method is used to discuss some critical issues that must be considered in seasonal adjustment process.

In sections six and seven, two critical issues that must be considered in the seasonal adjustment process are discussed. First of these is the selection of direct or indirect adjustment approach. Based on the criteria presented in section six, the indirect approach seems favorable in the adjustment of the Turkish monetary aggregates. The other issue is the selection of concurrent or projected factor adjustment approach. Due to the close-to-deterministic seasonal patterns of the monetary aggregates studied, the two approaches do not differ much. Therefore, not including the earlier mentioned drawbacks of concurrent adjustment, the factor-projected adjustment is preferable in the adjustment of the Turkish monetary aggregates.

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DEMETRA MANUAL*

1. WHAT IS DEMETRA?

DEMETRA is a seasonal adjustment program developed by Eurostat. It provides a tool for using and comparing the two seasonal adjustment methods recommended by Eurostat, the X-12 ARIMA (X12A) and TRAMO/SEATS (T/S).

DEMETRA eases access of non-specialists to T/S and X12A and provides a user friendly version of these methods. It automatically finds difficult time series in huge data sets and assists the user in their treatment. Additionally, it allows detailed analysis on single time series.

2. DETAILED ANALYSIS MODULE

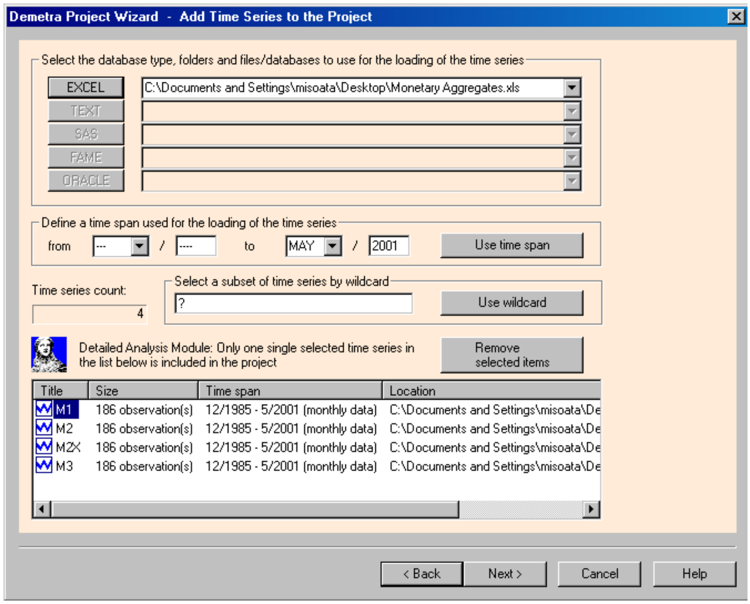
* This manual has been compiled from 'DEMETRA Manual' published by Eurostat, 2001. Specific issues concerning Turkey, are the views of the authors.

This module aims to allow in-depth comparisons of different sets of seasonal adjustment parameters for single series of particular interest. It provides nearly the whole capacity of the two seasonal adjustment methods: access to most of their options and to all their output including text output, data output, diagnostics and graphs.

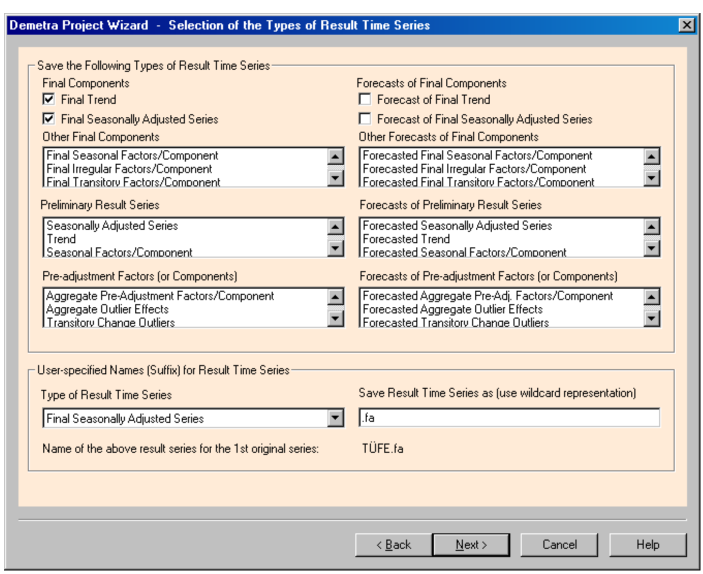
To begin a detailed analysis of a single time series, one should select the Detailed Analysis Module at the first window. The series to be seasonally adjusted can be obtained from different databases, of which the Excel is the most common. The series must be in a specific format to be imported into DEMETRA. Dates having the below specified format should start at A2 cell, leaving the A1 cell blank in Excel.

Date Format in Excel		
Montly Dates	**Quarterly Dates**	**Yearly Dates**
Jan-94	Jan-94	Jan-94
Feb-94	Apr-94	Jan-95
Mar.94	Jul-94	Jan-96
Apr-94	Oct-94	Jan-97
May.94	Jan-95	Jan-98
Jun-94	Apr-94	Jan-99
etc.	etc.	etc.

DEMETRA imports the series of the specified format and offers a time span analysis for the user. That is, the user can specify the period of the series to be seasonally adjusted. The user has to select a single time series to start a detailed analysis project.

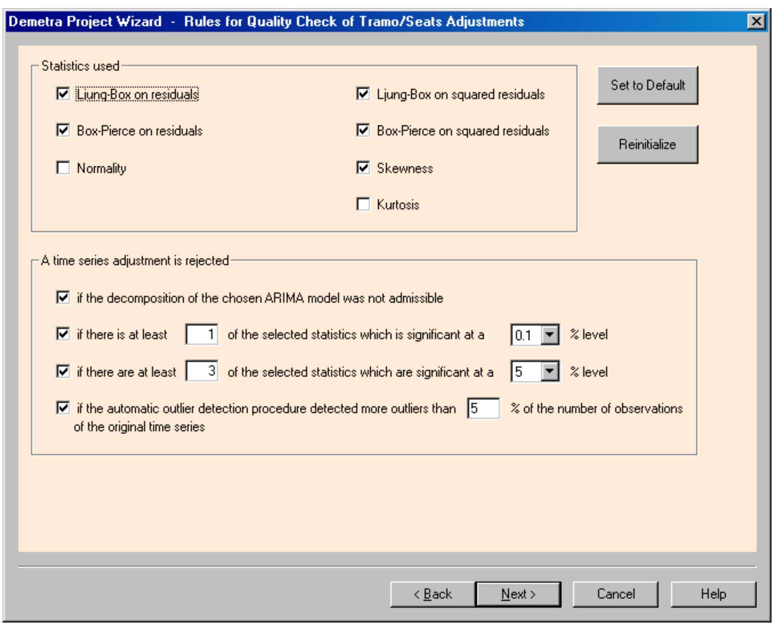


DEMETRA offers options to save the resulting output, such as the seasonally adjusted series, seasonal components, forecasts, etc., to a specified database. The below window asks the user to select the series to be saved to the database.



At the bottom of the window, an edit box is provided for customizing the suffixes of the names of the resulting time series. These names correspond to the names of the sheets in the Excel file if Excel is selected as the database. The user can select a different type of database or a different Excel file to save the output from the next window.

The diagnostic statistics of the fitted ARIMA model by T/S are shown in the window below. In the lower part of the window, the user can specify the significance levels of these test statistics.



2.1 Diagnostic Statistics

Ljung-Box on residuals: A statistic outside the confidence interval signifies that there is evidence of autocorrelations in the residuals. A linear structure is left in the residuals.

Ljung-Box on squared residuals: A statistic outside the confidence interval signifies that there is evidence of autocorrelations in the squared residuals. A non-linear structure is left in the residuals.

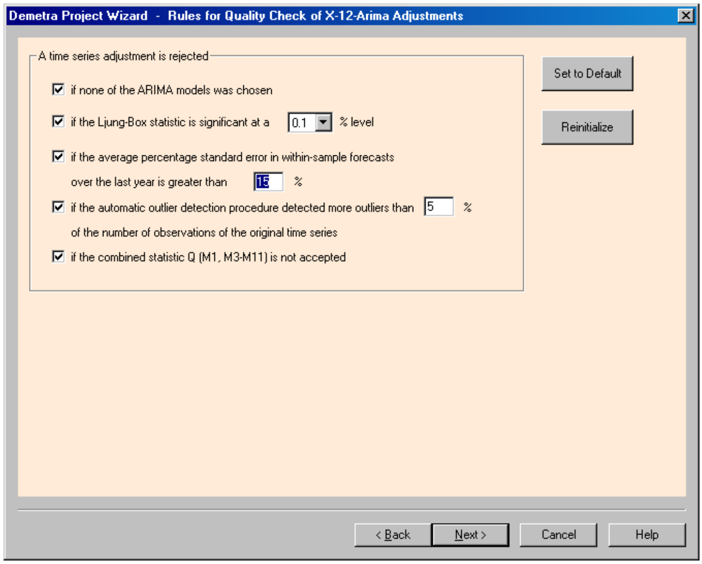
Box-Pierce on residuals: A statistic outside the confidence interval signifies that there is evidence of autocorrelations in the residuals at seasonal lags. A linear seasonal structure is left in the residuals.

Box-Pierce on squared residuals: A statistic outside the confidence interval signifies that there is evidence of autocorrelations in the squared residuals at seasonal lags. A non-linear seasonal structure is left in the residuals.

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

Skewness: A statistic outside the confidence interval signifies that there is evidence of skewness in the residuals. The residuals are asymmetrically distributed.

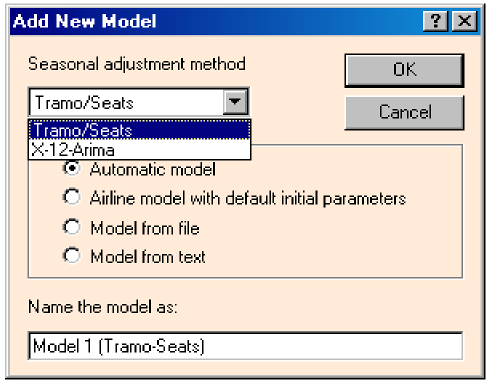
Kurtosis: A statistic outside the confidence interval signifies that there is evidence of kurtosis in the residuals.



Percentage of outliers: A high number of outliers signifies either a problem related to a weak stability of the process, or a problem with the reliability of the data. The ARIMA model cannot fit all of the observations.

ARIMA forecast error: A significant size of the ARIMA forecast errors signifies that the forecasts vary too much around the true values. The ARIMA model cannot fit the time series well.

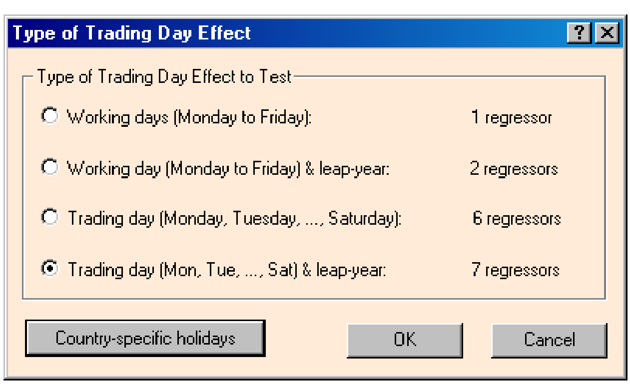
Combined Q statistic: A significant combined Q statistic means that some of X12A quality assessment statistics (M1, M3-M11) concerning the decomposition are outside the acceptance region.



The seasonal adjustment method is selected in the above window. The ARIMA modeling of the series are handled by automatic modeling or by a specified default model such as the Airline Model. The user-defined models can be incorporated into the program in the statistical modeling option of DEMETRA, which will be discussed later.

2.2 Adjustment of Calendar Effects

DEMETRA takes into account two types of working day and two types of trading day effects. These effects can be summarized as:



Working Days (Monday to Friday) There are no differences in the economical activity between the working days (Monday to Friday) but between these and non-working days (Saturday, Sunday). The varying number of these days is considered.

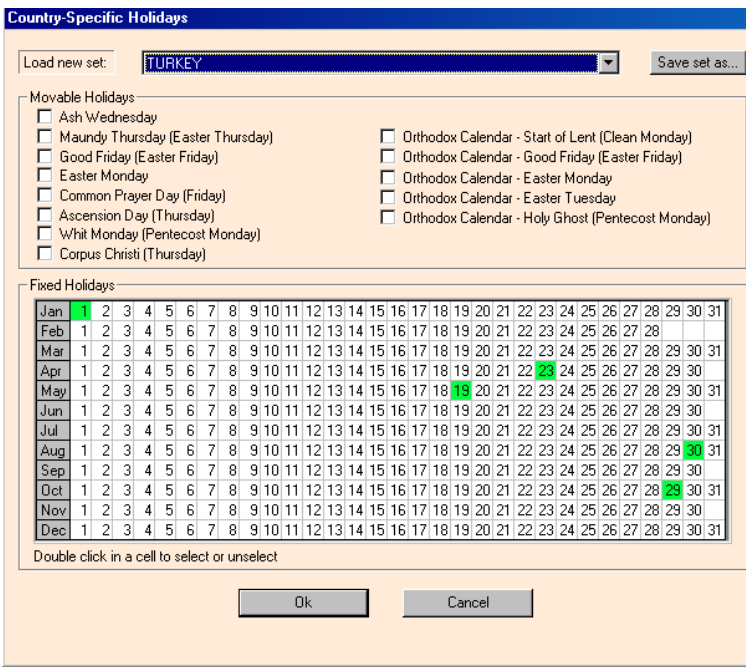
Working Days (Monday to Friday) & Leap Year: There are no differences in the economical activity between the working days (Monday to Friday) but between these and non-working days (Saturday, Sunday). The varying number of these days and also the total number of days per period are considered.

Trading Day (Monday, Tuesday,...,Saturday): There are differences in the economical activity between all days of the week. The varying number of these days is considered.

Trading Day (Monday, Tue,...,Sat) & Leap Year: There are differences in the economical activity between all days of the week. The varying number of these days and also the total number of days per period are considered.

Besides the trading day and working day effects, holiday effects should also be adjusted in the seasonal adjustment process. There are two types of holidays: country specific and moving holidays. For Turkey, country specific holidays are the five official holidays and moving holidays are the two religious holidays, which are Ramadan and Sacrifice holiday.

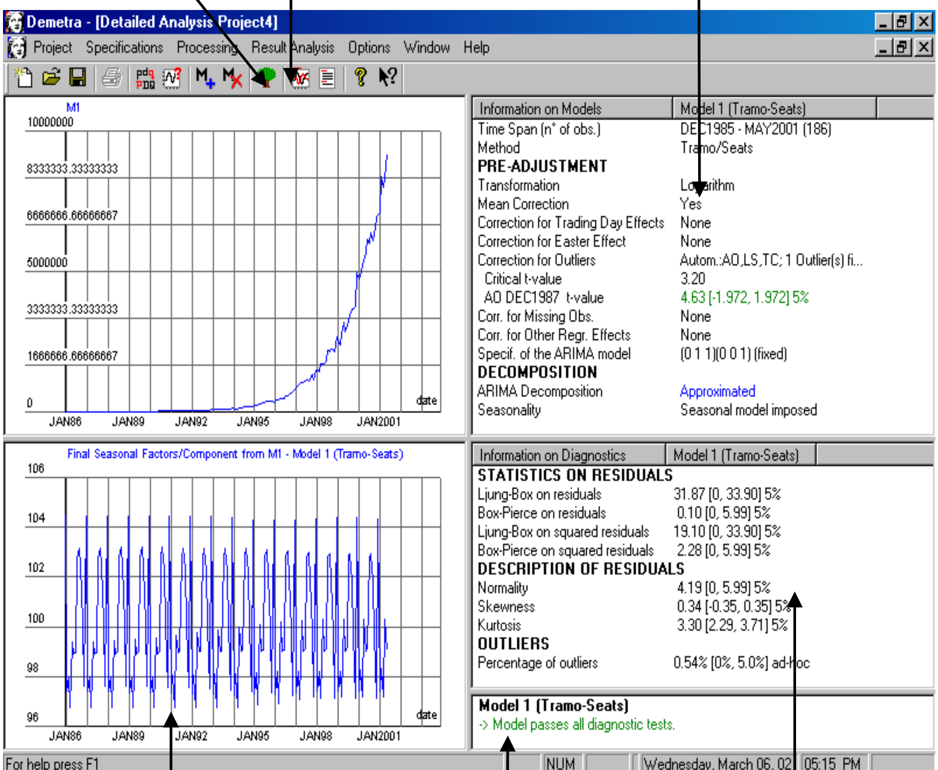
If the user clicks the country specific holiday adjustment button, the below dialog box appears. In order to specify the country specific holidays for Turkey, the user should double-click on the appropriate dates. The date specifications can be saved for further usage by clicking on "Save set as" button. For users working with international data, a default specific holiday set for 22 countries is provided on the "Load new set" menu.



Clicking on the 'Execute SA' button starts the seasonal adjustment process.

Graphical comparison tool offers methodological and other comparisons. It opens a new window with 4 non-overlapping areas for different graphs

The information on the fitted ARIMA model is summarized on the right-upper part of the window. In this part, the decomposition of the ARIMA model and the results of the tests for the log-transformation, mean correction, trading day correction and outlier detection are presented.

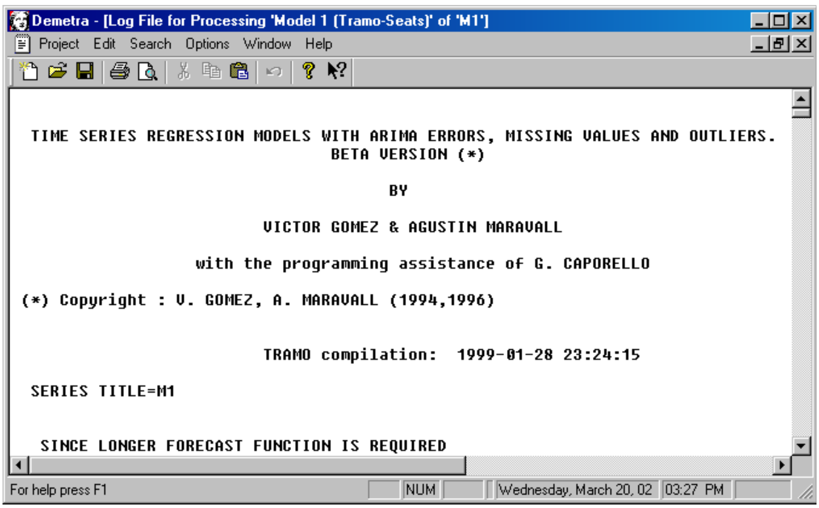


Graph of the seasonal factors or other result time series produced by the seasonal adjustment methods.

Text message shows significant diagnostic statistics and conclusion.

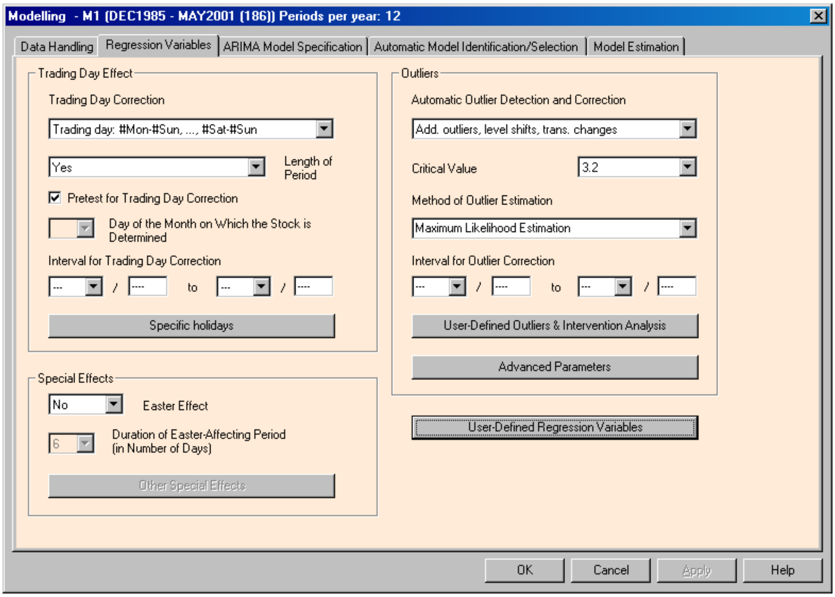
The diagnostic test results of the fitted ARIMA model are presented in the right-lower part of the window.

The detailed steps of the seasonal adjustment process and the statistical test results can be viewed in the log file (also called the output file) by selecting the Show Log File dialog box under the Result Analysis menu.



2.3 Modeling Options

Under the specifications menu, the modeling dialog box provides the user several options to manually control the seasonal adjustment process. On the Data Handling tab, options of transforming, mean correcting of the original series as well as different approaches of interpolating the missing observations are offered. On the ARIMA Model Specification tab, the user with prior experience on the model of the original series can manually change the automatically fitted seasonal ARIMA model decomposition. On the Automatic Model Identification/Selection and Model Estimation tabs, some advanced statistical options of automatic model identification and methods of model estimation criteria are presented.

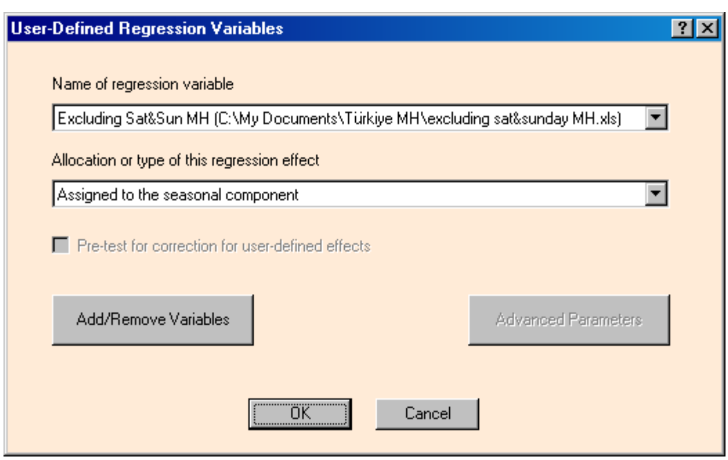


One of the most critical windows of the DEMETRA program is the Regression Variables tab where the trading day, holiday and outlier adjustments are defined in the seasonal adjustment process. The choice of the earlier mentioned trading day effect can be modified on the upper left part of the window. Also the leap year effect and the specific holiday effects can be altered here. Outlier adjustment options are presented on the upper right part of the window. The users with no prior experience on the outlier structure of the series are recommended to use the default outlier settings.

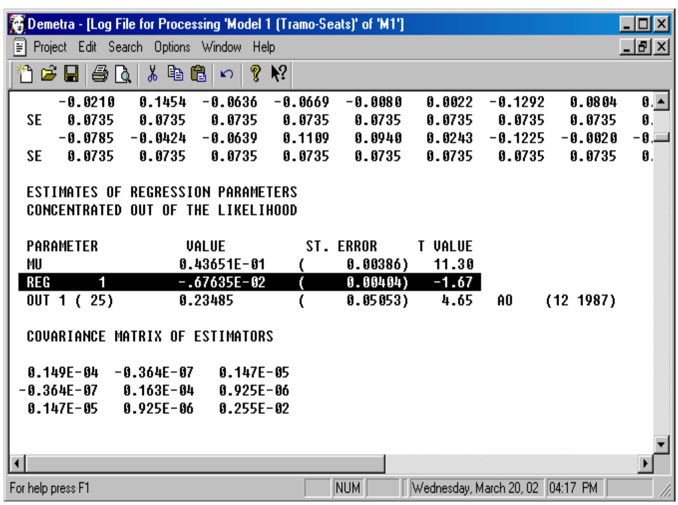
Different types of outliers are considered in the context of seasonal adjustment: additive outliers (AO), transitory change (TC) and level shift (LS). An additive outlier is able to catch a single point jump in the data, a temporary change a single point jump followed by a smooth return to the original path, and a level shift a permanent change in the level of the series. The user may limit the detection to 2 of the 3 outlier types (always including additive outliers).

On the other hand, in addition to several outlier types introduced, the user can specify outliers and intervention variables with a separate regression variable by clicking on the User Defined Outliers & Intervention Analysis button.

Besides the intervention variables, some special effects can be incorporated in the ARIMA model by the User Defined Regression Variables option. An example to such effects is the moving holiday effect, which is adjusted by adding a regression variable to the seasonal adjustment process. Such regression variable for Turkey, created by CBRT, is submitted in the appendix part of the manual. To incorporate this variable in the adjustment process, the regression variable should be in the above-specified Excel format. After selecting the appropriate regression variable, the user has to select the allocation of this variable to a specified component. For moving holiday effect, the variable must be assigned to the seasonal component.

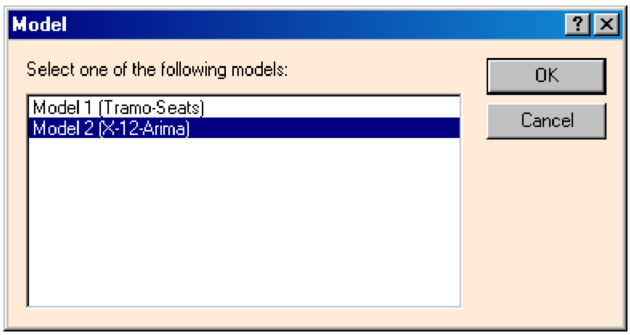


The significance of the assigned moving holiday effect is checked at the log file of the selected model. Under the “Estimates of Regression Parameters Concentrated Out of the Likelihood” heading, the test statistics of the regression variable are shown. In the example given below, the moving holiday effect is found to be insignificant. Therefore, the user must remove this variable from the process in the same way, as it is included, i.e. removing it under the User Defined Regression Variables menu.



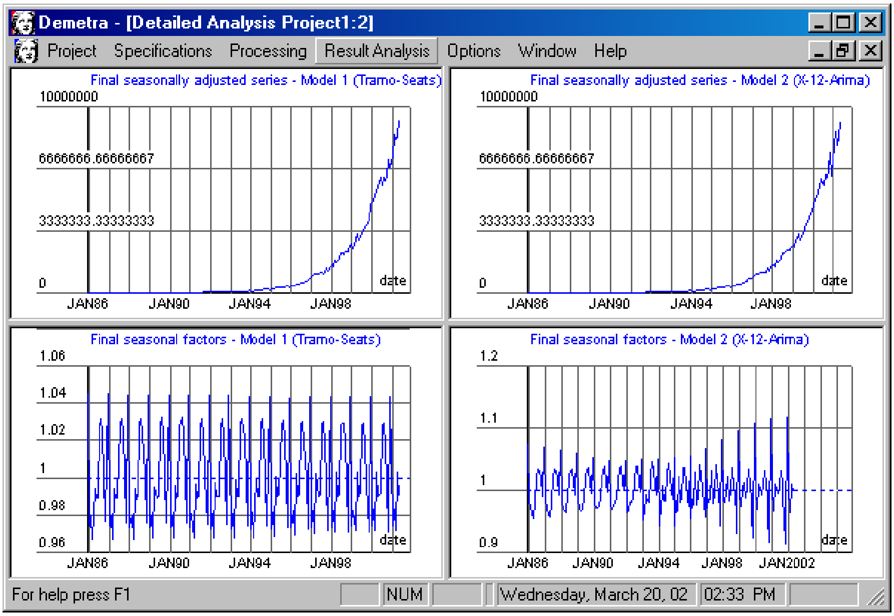
Under the Processing menu the ‘Save Results to Database’ option allows the user to save the parameters and the resulting time series. But, DEMETRA only saves the result time series that have been selected previously to the execution of the seasonal adjustment method. Thus, the user must make his choice of series before running the seasonal adjustment methods.

In a seasonal adjustment project, the user can specify different models for a single time series. Each model may have different seasonal techniques as well as different parameters, special effects and outliers. To add a new seasonal adjustment model, the user should select Add New Model option under the Specification menu.



Then the seasonal adjustment process is carried out from the beginning and the user will be offered a choice of models. In the example above the X12A method is chosen as the second model.

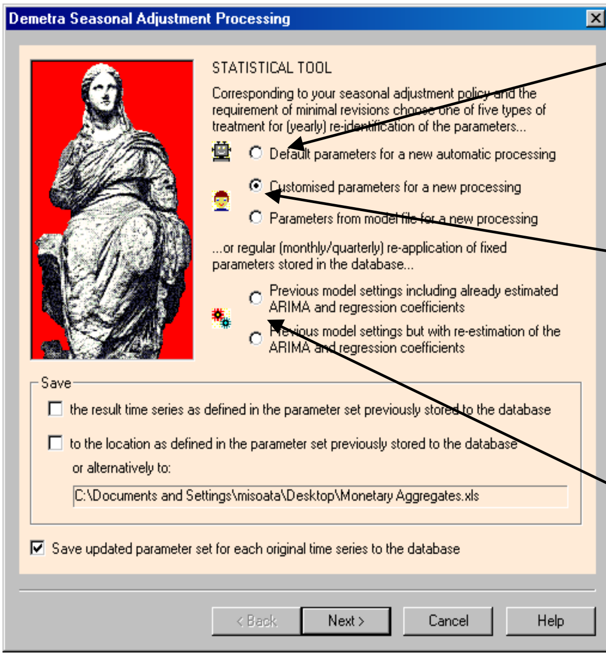
Graphical Comparison Tool under the specifications menu helps the user to compare different models. This option opens a new window with four non-overlapping areas for different graphs. By double clicking on any one of areas, the user selects the series to be viewed among the list of resulting series of the seasonal adjustment process such as the seasonally adjusted series, seasonal and trend components. On the upper parts of the next window, the seasonally adjusted series obtained from T/S and X12A methods and on the lower parts the corresponding seasonal factors are graphed. As can be seen, the seasonal factors, thus the seasonally adjusted series of the two methods depict different patterns.



In addition to saving the resulting series to an Excel file, the graphical comparison tool offers an alternative to reach the data values of the corresponding series. After the graphs are plotted, the data values can be exported to a notepad file by right clicking on the selected graph, which can be directly copied to an Excel file.

3. AUTOMATED ANALYSIS MODULE

The Automated Module is designed for automatic seasonal adjustment of lists of time series. This module is usually preferred when the seasonally adjusted data set includes large number of time series. It performs all the functions of detailed analysis module mentioned in this manual, but dialog boxes and menus are quite different.

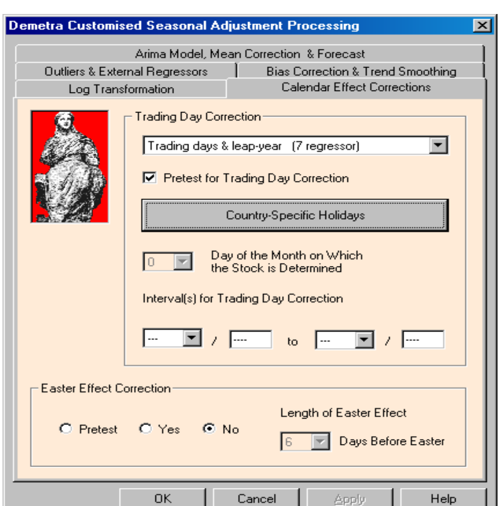


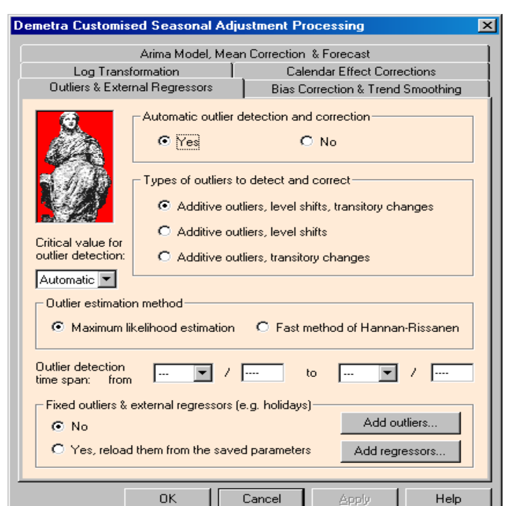
Default Parameters: For a simple seasonal adjustment taking into account only the trading day and country specific holiday effects.

Customized Parameters: For a complete option including moving holiday effect, pretest for log transformation and mean correction, outlier correction, missing observation interpolation.

Previous Model Settings: For a selection of the ARIMA model in re-adjustment of the series.

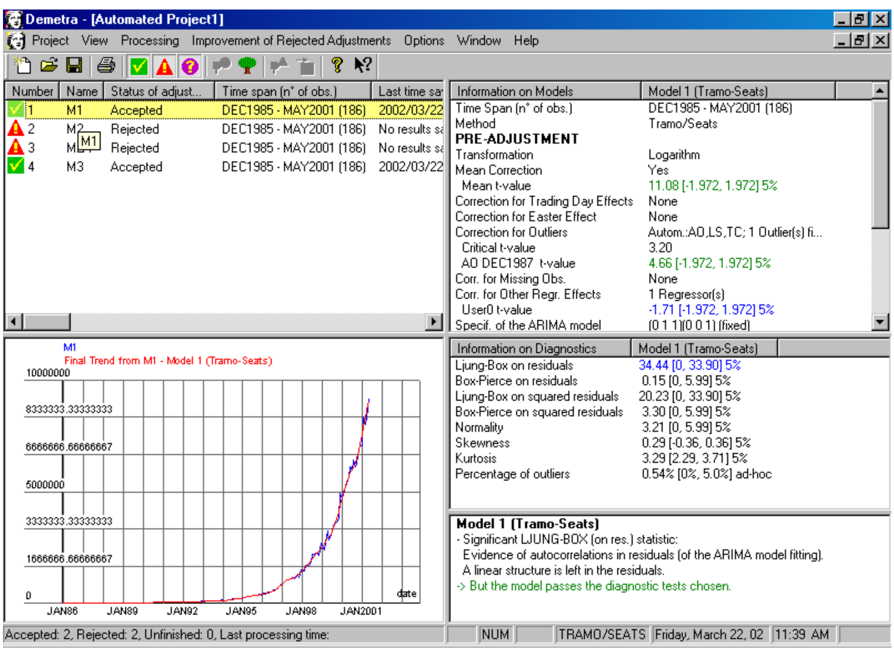
For a complete seasonal adjustment including the moving holiday effect, the "Customized Parameters" option should be selected. In Customized Seasonal Adjustment Processing window, five tabs are offered to make the necessary adjustments in the process.





Similar to Modeling menu under the Detailed Analysis Module, these five tabs offers calendar effect correction, outlier correction, test for log transformation and mean correction and ARIMA model identification

After the necessary adjustments are specified, the seasonal adjustment process for all the selected series can be started by clicking on the “execute SA” button. The accepted and rejected series are listed on the left upper part of the resulting window below.



For accepted models, the seasonally adjusted figures can be exported from the Automated Module. But for rejected models, to check and re-specify the diagnostics, a re-adjustment of the models should be performed in the Detailed Analysis Module.

APPENDIX: TURKISH MOVING HOLIDAYS

Moving Holiday excluding Sat&Sunday

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
1980	0	0	0	0	0	0	0	3	0	3	0	0
1981	0	0	0	0	0	0	0	1	0	2	0	0
1982	0	0	0	0	0	0	2	0	4	0	0	0
1983	0	0	0	0	0	0	3	0	2	0	0	0
1984	0	0	0	0	0	1	2	0	2	0	0	0
1985	0	0	0	0	0	2	0	4	0	0	0	0
1986	0	0	0	0	0	3	0	2	0	0	0	0
1987	0	0	0	0	1	0	0	3	0	0	0	0
1988	0	0	0	0	3	0	3	0	0	0	0	0
1989	0	0	0	0	1	0	2	0	0	0	0	0
1990	0	0	0	2	0	0	4	0	0	0	0	0
1991	0	0	0	3	0	3	0	0	0	0	0	0
1992	0	0	0	1	0	2	0	0	0	0	0	0
1993	0	0	3	0	0	4	0	0	0	0	0	0
1994	0	0	2	0	2	0	0	0	0	0	0	0
1995	0	0	1	0	3	0	0	0	0	0	0	0
1996	0	3	0	3	1	0	0	0	0	0	0	0
1997	0	2	0	2	0	0	0	0	0	0	0	0
1998	2	0	0	4	0	0	0	0	0	0	0	0
1999	3	0	3	0	0	0	0	0	0	0	0	0
2000	1	0	2	0	0	0	0	0	0	0	0	3
2001	0	0	4	0	0	0	0	0	0	0	0	2
2002	0	2	0	0	0	0	0	0	0	0	0	2
2003	0	4	0	0	0	0	0	0	0	0	3	0

Moving Holiday excluding Sunday

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
1980	0	0	0	0	0	0	0	3	0	3	0	0
1981	0	0	0	0	0	0	0	2	0	3	0	0
1982	0	0	0	0	0	0	3	0	4	0	0	0
1983	0	0	0	0	0	0	3	0	3	0	0	0
1984	0	0	0	0	0	2	2	0	3	0	0	0
1985	0	0	0	0	0	3	0	4	0	0	0	0
1986	0	0	0	0	0	3	0	3	0	0	0	0
1987	0	0	0	0	2	0	0	4	0	0	0	0
1988	0	0	0	0	3	0	3	0	0	0	0	0
1989	0	0	0	0	2	0	3	0	0	0	0	0
1990	0	0	0	3	0	0	4	0	0	0	0	0
1991	0	0	0	3	0	3	0	0	0	0	0	0
1992	0	0	0	2	0	3	0	0	0	0	0	0
1993	0	0	3	0	0	4	0	0	0	0	0	0
1994	0	0	2	0	3	0	0	0	0	0	0	0
1995	0	0	2	0	4	0	0	0	0	0	0	0
1996	0	3	0	3	1	0	0	0	0	0	0	0
1997	0	2	0	3	0	0	0	0	0	0	0	0
1998	3	0	0	4	0	0	0	0	0	0	0	0
1999	3	0	3	0	0	0	0	0	0	0	0	0
2000	2	0	3	0	0	0	0	0	0	0	0	3
2001	0	0	4	0	0	0	0	0	0	0	0	2
2002	0	3	0	0	0	0	0	0	0	0	0	3
2003	0	4	0	0	0	0	0	0	0	0	3	0