# PROGRAM TSW REFERENCE MANUAL

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Banco de España - Servicio de Estudios
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## Abstract

The user instructions for Program TSW are provided. TSW is a Windows version, developed by G.Caporello and A.Maravall, of Programs TRAMO and SEATS (Gómez and Maravall, 1996), that incorporates several modifications and new facilities.

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## INSTALLATION

A) Local installation.

For local installation of TSW, create a directory, say TEMP, with six subdirectories, DISK1, DISK2,..., DISK6. Copy the file Disk1.zip in DISK.1, the file Disk2.zip in DISK2,..., and the file Disk6.zip in DISK6. Then, extract the six files and execute SETUP. EXE in DISK1. The program autoinstalls itself. For future versions, you do not have to uninstall the program. Simply follow the same installation steps; the old version will be automatically replaced. The program is installed in the directory PROGRAM FILES\TSW; the output file of the program will be deposited in PROGRAM FILES\TSW\OUTPUT, and the arrays for the graphs in PROGRAM FILES\TSW\GRAPH. To execute the program simply follow the steps: "Start->Programs->Seats Tramo Windows->TSW".

Note: Everytime the program is restarted, the OUTPUT directory is emptied.

B) Network installation.

The directory NETINSTALL contains the file "netinstall.exe" which is a small program for installation of TSW in a network. To do this, first, TSW should be installed in the server, and then each user should execute the program netinstall.exe from their own PC (the program resides in the server). The only information the user should supply is the name of the local destination directory of TSW on the user PC. In this PC several directories will be created (OUTPUT, GRAPH, BIN,...) where the output files of TSW will be deposited (the programs will remain in the server).

## 1. BRIEF DESCRIPTION OF THE PROGRAMS

TRAMO and SEATS are two programs developed by Victor Gómez and Agustín Maravall for applied time series analysis. Program TERROR is a particular application of TRAMO, and program TSW is a Windows version of TRAMO-SEATS developed by Gianluca Caporello and Agustín Maravall. The programs are briefly summarized in the following pages; the first two sections are a revised version of sections 1.1,2.1, and 2.2 in Gómez and Maravall (1996)

### 1.1 PROGRAM TRAMO

TRAMO ("Time Series **R**egression with **A**rima Noise, **M**issing Observations and **O**utliers") is a program for estimation, forecasting, and interpolation of regression models with missing observations and ARIMA errors, in the presence of possibly several types of outliers (no restriction is imposed on the location of the missing observations in the series). The program can be run in an entirely automatic manner.

Given the vector of observations:

$$z = ( z_{t_1}, \ldots, z_{t_M} )' \qquad (1)$$

where $0 < t_1 < \ldots < t_M$, the program fits the regression model

$$z_t = y'_t \beta + x_t, \qquad (2)$$

where $\beta = ( \beta_1, \ldots, \beta_n )'$ is a vector of regression coefficients, $y'_t = ( y_{1t}, \ldots, y_{nt} )$ denotes n regression variables, and $x_t$ follows the general ARIMA process

$$\phi(B)\delta(B) x_t = \theta(B) a_t, \qquad (3)$$

where B is the backshift operator; $\phi(B)$, $\delta(B)$ and $\theta(B)$ are finite polynomials in B, and $a_t$ is assumed a n.i.i.d $(0, \sigma_a^2)$ white-noise innovation.

The polynomial $\delta(B)$ contains the unit roots associated with differencing (regular and seasonal), $\phi(B)$ is the polynomial with the stationary autoregressive roots, and $\theta(B)$ denotes the (invertible) moving average polynomial. In TRAMO, they assume the following multiplicative form:

$$\delta(B) = (1-B)^d (1-B^s)^D$$
$$\phi(B) = (1+\phi_1 B + \ldots + \phi_p B^p)(1+\Phi_1 B^s + \ldots + \Phi_P B^{s \times P})$$
$$\theta(B) = (1+\theta_1 B + \ldots + \theta_q B^q)(1+\Theta_1 B^s + \ldots + \Theta_Q B^{s \times Q}),$$

where s denotes the number of observations per year. The model may contain a constant $\mu$, equal to the mean of the differenced series $\delta(B) z_t$. In practice, this parameter is estimated as one of the regression parameters in (2).

The regression variables can be input by the user (such as a variable capturing holidays, or an economic variable thought to be related with $z_t$), or generated by the program. The variables that can be generated are trading day, easter effect and intervention variables (Box and Tiao, 1975) of the type:

a) dummy variables;
b) any possible sequence of ones and zeros;
c) $1/(1-\delta B)$ of any sequence of ones and zeros, where $0< \delta \leq 1$;
d) $1/(1-\delta_s B^s)$ of any sequence of ones and zeros, where $0< \delta_s \leq 1$;
e) $1/(1-B)(1-B^s)$ of any sequence of ones and zeros.

The program:

1) estimates by exact maximum likelihood (or unconditional/conditional least squares) the parameters in (2) and (3);
2) detects and corrects for several types of outliers;
3) computes optimal forecasts for the series, together with their MSE;
4) yields optimal interpolators of the missing observations and their associated MSE; and
5) contains an option for automatic model identification and automatic outlier treatment.

The basic methodology followed is described in Gómez and Maravall (1992, 1994, 1996, 2001a), and Gómez, Maravall and Peña (1999). The program is aimed at monthly or lower frequency data, the maximum number of observations is 600 and the minimum depends on the periodicity of the data (in particular, 16 for quarterly and 36 for monthly data).

Estimation of the regression parameters (including intervention variables and outliers, and the missing observations among the initial values of the series), plus the ARIMA model parameters, can be made by concentrating the former out of the likelihood (default), or by joint estimation. Several algorithms are available for computing the likelihood or more precisely, the nonlinear sum of squares to be minimized. When the differenced series can be used, the algorithm of Morf, Sidhu and Kailath (1974) is employed, with a simplification similar to that of Mélard (1984), but also extended to multiplicative seasonal moving average models. For the nondifferenced series, it is possible to use the ordinary Kalman filter (default option), or its square root version (see Anderson and Moore, 1979). The latter is adequate when numerical difficulties arise; however it is markedly slower. By default, the exact maximum likelihood method is employed. Nonlinear maximization of the likelihood function and computation of the parameter estimates standard errors is made using Marquardt's method and first numerical derivatives.

Estimation of regression parameters is made by using first the Cholesky decomposition of the inverse error covariance matrix to transform the regression equation (the Kalman filter provides an efficient algorithm to compute the variables in this transformed regression). Then, the resulting least squares problem is solved by applying the QR algorithm, where the Householder orthogonal transformation is used. This procedure yields an efficient and numerically stable method to compute GLS estimators of the regression parameters, which avoids matrix inversion.

For forecasting, the ordinary Kalman filter or the square root filter options are available. These algorithms are applied to the original series; see Gómez and Maravall (1993) for a more detailed discussion on how to build initial conditions on a nonstationary situation.

Missing observations can be handled in two equivalent ways. The first one is an extension to nonstationary models of the skipping approach of Jones (1980), and is described in Gómez and Maravall (1994). In this case, interpolation of missing values is made by a simplified Fixed Point Smoother, and yields identical results to Kohn and Ansley (1986). The second one consists of assigning a tentative value and specifying an additive outlier to each missing observation. If this option is used, the interpolator is the difference between the tentative value and the estimated regression parameter and coincides with the interpolator obtained with the skipping approach (the likelihood is corrected so that it coincides with that of the skipping approach; see Gómez, Maravall and Peña (1999) for more details.) When concentrating the regression parameters out of the likelihood, mean squared errors of the forecasts and interpolations are obtained following the approach of Kohn and Ansley (1985).

When some of the initial missing values are unestimable (free parameters), the program detects them, and flags the forecasts or interpolations that depend on these free parameters. The user can then assign arbitrary values (typically, very large or very small) to the free parameters and rerun the program. Proceeding in this way, all parameters of the ARIMA model can be estimated because the function to minimize does not depend on the free parameters. Moreover, it will be evident which forecasts and interpolations are affected by these arbitrary values because they will strongly deviate from the rest of the estimates. However, if all unknown parameters are jointly estimated, the program may not flag all free parameters. It may happen that there is convergence to a valid arbitrary set of solutions (i.e., that some linear combinations of the initial missing observations, including the free parameters, are estimable).

The program has a facility for detecting outliers and for removing their effect; the outliers can be entered by the user or they can be automatically detected by the program, using an original approach based on those of Tsay (1986) and Chen and Liu (1993). The outliers are detected one by one, as proposed by Tsay (1986), and multiple regressions are used, as in Chen and Liu (1993), to detect spurious outliers. The procedure used to incorporate or reject outliers is similar to the stepwise regression procedure for selecting the "best" regression equation.

In brief, regression parameters are initialized by OLS and the ARIMA model parameters are first estimated with two regressions, as in Hannan and Risannen (1982). Next, the Kalman filter and the QR algorithm provide new regression parameter estimates and regression residuals. For each observation, t-tests are computed for several types of outliers. If there are outliers whose absolute *t*-values are greater than a pre-selected critical level *C*, the one with the greatest absolute *t*-value is selected. Otherwise, the series is free from outlier effects and the algorithm stops.

If some outlier has been detected, the series is corrected by its effect and the ARMA model parameters are re-estimated. Then, a multiple regression is performed using the Kalman filter and the QR algorithm. If there are some outliers whose absolute *t*-value is removed from the regression residuals provided by the last multiple regression, *t*-tests are computed for the different types of outliers and for each observation. If there are outliers whose absolute *t*-values are greater than the critical level *C*, the one with the greatest absolute *t*-value is selected and the algorithm goes on to the estimation of the ARMA model parameters to iterate. Otherwise, the algorithm stops. A notable feature of this algorithm is that all calculations are based on linear regression techniques, which reduces computational time. By default, three types of outliers are considered: additive outlier, level shift, and transitory change.

The program also contains a facility to pretest for the log-level specification (based on a comparision of the BIC using both specifications) and, if appropriate, for the possible presence of Trading Day and Easter effects (the pretests are made with regressions using the default model for the noise and, if the model is subsequently changed, the test is redone); it further performs an automatic model identification of the ARIMA model. This is done in two steps. The first one yields the nonstationary polynomial $\delta(B)$ of model (3). This is done by iterating on a sequence of AR and ARMA(1,1) models (with mean), which have a multiplicative structure when the data is seasonal. The procedure is based on results of Tiao and Tsay (1983), and Tsay (1984). Regular and seasonal differences are obtained, up to a maximum order of $\Delta^2\Delta_s$, where $\Delta = 1-B$ and $\Delta_s = 1-B^s$.

The second step identifies an ARMA model for the stationary series (corrected for outliers and regression-type effects) following the Hannan-Rissanen procedure, with an improvement which consists of using the Kalman filter instead of zeros to calculate the first residuals in the computation of the estimator of the variance of the innovations of model (3). For the general multiplicative model

$$\phi_p(B)\Phi_P(B^s)x_t = \theta_q(B)\Theta_Q(B^s)a_t ,$$

the search is made over the range $0 \le (p,q) \le 3$ , $0 \le (P,Q) \le 2$ . This is done sequentially (for fixed regular polynomials, the seasonal ones are obtained, and vice versa), and the final orders of the polynomials are chosen according to the BIC criterion, with some possible constraints aimed at increasing parsimony and favouring "balanced" models (similar AR and MA orders).

Finally, the program combines the facilities for automatic detection and correction of outliers and automatic ARIMA model identification just described in an efficient way, so that it can perform automatic model identification of a nonstationary series in the presence of outliers and missing observations (perhaps with some regression effects).

The default model in TRAMO is the so-called Airline Model, popularized by Box and Jenkins (1970). The model is given by the equation

$$\Delta\Delta_s x_t = (1+\theta_1 B)(1+\theta_s B^s)a_t, \qquad (4)$$

with $-1 \le (\theta_1, \theta_s) \le 1$. It is often found appropriate for many series (see the large-scale study in Fischer and Planas (2000)), and displays many convenient features (see, for example, Maravall (1998)); in particular it encompasses many other models, including models with close to deterministic trend or seasonality, or models without seasonality. For very short series, for which the automatic model identification is unreliable, TRAMO relies heavily on the Airline model specification.

Although TRAMO can obviously be used by itself, for example, as an outlier detection an interpolation or a forecasting program, it can also be seen as a program that polishes a contaminated "ARIMA series". That is, for a given time series, it interpolates the missing observations, identifies outliers and removes their effect, estimates Trading Day and Easter Effect, etc..., and eventually produces a series that can be seen as the realization of a linear stochastic process (i.e., an ARIMA model). Thus, TRAMO, can be used as a pre-adjustment program to SEATS (see below), which decomposes then the "linearized series" and its forecasts into its stochastic components.

Both programs can handle routine applications to a large number of series and provide a complete model-based solution to the problems of forecasting, outlier correction, interpolation and signal extraction for nonstationary time series.

## 1.2 PROGRAM SEATS

### 1.2.1 Brief Description

SEATS ("**S**ignal **E**xtraction in **A**RIMA **T**ime **S**eries") is a program for decomposing a time series into its unobserved components (i.e., for extracting from a time series its different signals), following an ARIMA-model-based method. The method was developed from the work of Cleveland and Tiao (1976), Box, Hillmer and Tiao (1978), Burman (1980), Hillmer and Tiao (1982), Bell and Hillmer (1984), and Maravall and Pierce (1987), in the context of seasonal adjustment of economic time series. In fact, the starting point for SEATS was a program built by Burman for seasonal adjustment at the Bank of England (1982 version).

In the standard case, SEATS receives from TRAMO the original series, the deterministic effects TRAMO has estimated (outliers, trading day or easter effects, and in general regression variable effects), the interpolated series with the deterministic effects removed (i.e., the "linearized" series $x_t$ in (2)), and the ARIMA model identified and estimated for these series, given by (3). The model can be written in detailed form as

$$\phi_r(B)\phi_s(B^s)\Delta^d\Delta_s^D x_t = \theta_r(B)\theta_s(B^s)a_t + c \,, \qquad (5)$$

and, in concise form, as

$$\Phi(B)x_t = \theta(B)a_t + c \,, \qquad (6)$$

where $\Phi(B) = \phi(B)\delta(B)$ represents the complete autoregressive polynomial, including all unit roots. Notice that, if p denotes the order of $\phi(B)$ and q the order of $\theta(B)$, then the order of $\Phi(B)$ is $P = p + d + D \times s$ .

The program decomposes a series that follows model (5) into several components. The decomposition can be multiplicative or additive. Since the former becomes the second by taking logs, we shall use in the discussion an additive model, such as

$$x_t = \sum_i x_{it} \,, \qquad (7)$$

where $x_{it}$ represents a component. The component that SEATS considers are:

$x_{pt}$ = the TREND-CYCLE component,

$x_{st}$ = the SEASONAL component,

$x_{ct}$ = the TRANSITORY component,

$x_{ut}$ = the IRREGULAR component.

Broadly, the trend-cycle component captures the low-frequency variation of the series and displays a spectral peak at frequency 0 the seasonal component, in turn, captures the spectral peaks at seasonal frequencies; and the irregular component captures erratic, white-noise behavior, and hence has a flat spectrum. The transitory component is a zero-mean stationary component that picks up transitory fluctuations that should not contaminate the trend-cycle or seasonal component and are not white-noise (see next section). The components are determined and fully derived from the structure of the (aggregate) ARIMA model for the observed series, which can be directly identified from the data. Like TRAMO, SEATS is aimed at monthly or lower frequency data and has the same restrictions on the maximum and minimum number of observations.

The decomposition assumes orthogonal components, and each one will have in turn an ARIMA expression. In order to identify the components, we will require that (except for the irregular one) they be clean of noise. This is called the "canonical" property, and implies that no additive white noise can be extracted from a component that is not the irregular one. The variance of the latter is, in this way, maximized, and, on the contrary, the trend-cycle and seasonal component are as stable as possible (compatible with the stochastic nature of model (6)). Although an arbitrary assumption, since any other admissible component can be expressed as the canonical one plus independent white-noise, lacking a priori information on the noise variance, the assumption seems rather sensible.

The model that SEATS assumes is that of a linear time series with Gaussian innovations. In general, SEATS is designed to be used with the companion program TRAMO, which removes from the series special effects, such as Trading Day, Easter, holiday, and intervention or regression variable effects, identifies and removes several types of outliers, and interpolates missing observations. TRAMO passes to SEATS the linearized series and the ARIMA model for this series, perhaps obtained through the automatic facility. When no outliers or deterministic effects have to be removed and there are no missing values, SEATS can be used by itself because it also contains an ARIMA estimation routine. This routine is also used when the TRAMO model should be modified in order to decompose the series (such is the case, for example, when the TRAMO model does not accept an admissible decomposition). In either case, SEATS performs a control on the AR and MA roots of the model. When the modulus of a root converges within a preset interval around 1, the program automatically fixes the root. If it is an AR root, the modulus is made 1; if it is an MA root, it is fixed to the lower limit (by default, .99). This simple feature, we have found, makes the program very robust to over- and under-differencing.

SEATS computes new residuals for the series in the following way. The TRAMO residuals are obtained with the Kalman filter and are equal in number to the number of observations in the series minus the sum of the number of observations lost by differencing and the degrees of freedom lost by estimation of outliers and other deterministic effects. SEATS uses the ARIMA model to filter the linearized series and estimates by maximum likelihood the residuals that correspond to the observations lost by differencing. In this way, SEATS assigns a residual for each period spanned by the original series. The SEATS residuals are called "extended residuals"; for the overlapping periods, they are extremely close to the TRAMO ones. The extended residuals are subject to the same diagnostics as the ones in TRAMO (presence of autocorrelation, presence of seasonality, randomness of signs, skewness, kurtosis, normality, and nonlinearity). The program proceeds then to decompose the ARIMA model. This is done in the frequency domain. The spectrum (or pseudospectrum) is partitioned into additive spectra, associated with the different components. (These are determined, mostly, from the AR roots of the model.) The canonical condition identifies a unique decomposition, from which the ARIMA models for the components are obtained (including the component innovation variances).

For a particular realization $[x_1, x_2, \dots, x_T]$, the program yields the Minimum Mean Square Error (MMSE) estimators of the components, computed with a Wiener-Kolmogorov-type of filter applied to the finite series by extending the latter with forecasts and backcasts (use is made of the efficient Burman-Wilson algorithm; see Burman, 1980). For $i = 1, \ldots, T$, the estimate $\hat{x}_{it|T}$, equal to the conditional expectation $E(x_{it} | x_1, \ldots, x_T)$, is obtained for all components.

For a large enough series and values of t not close to 1 or T, the estimator $\hat{x}_{it|T}$ becomes the "final" or "historical" estimator, which we shall denote $\hat{x}_{it}$. (In practice, it is achieved for large enough $k = T - t$, and the program indicates how large k can be assumed to be.) For $t = T$, the concurrent estimator, $\hat{x}_{iT|T}$, is obtained, i.e., the estimator for the last observation of the series. The final and concurrent estimators are the ones of most applied interest. When $T - k < t < T, \hat{x}_{it|T}$ yields a preliminary estimator, and, for $t > T$, a forecast. Besides their estimates, the program produces several years of forecasts of the components, as well as standard errors (SE) of all estimators and forecasts. For the last two and the next two years, the SE of the revision the preliminary estimator and the forecast will undergo is also provided. The program further computes MMSE estimates of the innovations in each one of the components.

The joint distribution of the (stationary transformation of the) components and of their MMSE estimators are obtained; they are characterized by the variances and auto- and cross-correlations. The comparison between the theoretical moments for the MMSE estimators and the empirical ones obtained in the application yields additional elements for diagnosis (see Maravall, 1987). The program also presents the Wiener-Kolmogorov filter for each component and the filter which expresses the weights with which the different innovations $a_j$ in the series contribute to the estimator $\hat{x}_{it|T}$. These weights directly provide the moving average expressions for the revisions. Next, an analysis of the estimation errors for the trend and for the seasonally adjusted series is performed. Let

$$d_{it} = x_{it} - \hat{x}_{it},$$

$$d_{it|T} = x_{it} - \hat{x}_{it|T},$$

$$r_{it|T} = \hat{x}_{it} - \hat{x}_{it|T},$$

denote the final estimation error, the preliminary estimation error, and the revision error in the preliminary estimator $\hat{x}_{it|T}$. The variances and autocorrelation functions for $d_{it}, d_{it|t}, r_{it|t}$ are displayed. (The autocorrelations are useful to compute SE of linearized rates of growth of the component estimator.) The program then shows how the variance of the revision error in the concurrent estimator $r_{it|t}$ decreases as more observations are added, and hence the time it takes in practice to converge to the final estimator. Similarly, the program computes the deterioration as the forecast moves away from the concurrent estimator and, in particular, what is the expected improvement in Root MSE associated with moving from a once-a-year to a concurrent seasonal adjustment practice. Finally, the SE of the estimators of the linearized rates of growth most closely watched by analysts are presented, for the concurrent estimator of the rate and its successive revisions, both for the trend and seasonally adjusted series. The SEs computed assume that the ARIMA model for the observed series is correct. Further details can be found in Maravall (1988, 1993, 1995), Gomez and Maravall (1992, 2001b), and Maravall and Planas (1999). For a basic introduction to the time series analysis concepts and tools in connection with TRAMO-SEATS, see Kaiser and Maravall (2000).

As in TRAMO, the default model in SEATS is the Airline Model, given by (4), which provides very well behaved estimation filters for the components. The implied components have models of the type

$$\Delta^2 x_{pt} = \theta_p(B) a_{pt} , \tag{8}$$

$$S x_{st} = \theta_s(B) a_{st} , \tag{9}$$

where $S = 1 + B + \ldots + B^{s-1}$, is the annual aggregation operator and $\theta_p(B)$ and $\theta_s(B)$ are both of order 2 and $(s-1)$, respectively. Compared to other fixed filters, the default model allows for the observed series to estimate 3 parameters: $\theta_1$, related to the stability of the trend-cycle component; $\theta_s$, related to the stability of the seasonal component; and $\sigma_a^2$, a measure of the overall predictability of the series. Thus, to some extent, even in this simple fixed model application, the filters for the component estimators adapt to the specific structure of the series. Notice that model (8) implies a locally linear trend, that becomes quadratic when model (4) contains a constant, and that model (9) implies that the sum of the seasonal component over a one-year period will, on average, be zero. The fact that, for a particular year, the seasonal component does not exactly cancel out implies that the annual averages of the original and seasonally adjusted series will not be equal. This is a typical feature of stochastic models with stochastic (or "moving") components.

Programs TRAMO and SEATS provide a fully model-based method for forecasting and signal extraction in univariate time series. (The relation between them is somewhat similar to the one between the programs REGARIMA and the revised X11 ARIMA that form the new method X12 ARIMA; see Findley et al, 1998.) The procedure is flexible, yet robust and reliable. Due to the model-based features, it becomes a powerful tool for detailed analysis of important series in short-term policy making and monitoring, yet TRAMO-SEATS can also be efficiently used for routine application to a very large number of series due to the automatic procedures available. The standard automatic procedure pretests for the log-level specification and, if appropriate, for the possible presence of Trading Day and Easter effects; it further performs an automatic model identification and outlier detection and correction procedures (for several types of outliers), interpolates the missing values if any, and decomposes the series net of the previous (deterministic) effects into a seasonal, trend-cycle, transitory, and irregular components. (If the identified ARIMA model does not accept an admissible decomposition, it is automatically replaced by a decomposable approximation). Finally, the components (and forecasts thereof) estimated by SEATS are modified to incorporate the deterministic effects that were estimated by TRAMO and removed from the series in order to linearize it. As a general rule, additive outliers are added to the irregular component, transitory changes to the transitory component, and level shifts to the trend. Trading Day and Easter effects are added to the seasonal component, as well as Holiday effect; their sum is called Calendar effect. Regression variables can be added to any one of the components, or (by default) form a separate component. When added to the seasonal component, SEATS checks that the effect is properly centered.

### 1.2.2 Decomposition of the ARIMA Model

Let the total AR polynomial $\Phi(B)$ of the ARIMA model (6) be factorized as

$$\Phi(B) = \phi_r(B)\phi_s(B^s)\Delta^d \Delta_s^D .$$

The roots of $\Phi$ (B) are assigned to the unobserved components as follows.

Roots of $\Delta^d = 0$ : Assigned to trend-cycle component.

Roots of $\Delta_s{}^D = 0$ : Factorizing it as $(\Delta S)^D = 0$ , where

$$S = 1 + B + \ldots + B^{s-1}$$

- the root of $\Delta = 0$ goes to the trend-cycle.
- the roots of S = 0 go to the seasonal component.

If $\phi_r(B) = 1 + \phi_1 B + \ldots + \phi_p B^p$ and $\phi_s(B) = 1 + \phi_s B^s$, let $z = B^{-1}$ and consider the roots of the polynomials

$$\phi_r(z) = z^p + \phi_1 z^{p-1} + \ldots + \phi_p,$$

$$\phi_s(z) = z^s + \phi_s.$$

Roots of $\phi_r$ ( z ) :

Real positive roots:

- If modulus $\geq$ k, assigned to trend-cycle.
- If modulus < k, assigned to transitory component.

Real negative roots:

- If s $\neq$ 1, and modulus $\geq$ k assigned to seasonal component (root implies a period of 2).
- If s $\neq$ 1 and modulus < k, assigned to transitory component
- If s = 1 (annual data), assigned to transitory component.

Complex roots: Let $\omega$ denote the frequency of the root.

If $\omega \in$ [a seasonal frequency $\pm\epsilon$], assigned to seasonal component.

- Otherwise, assigned to transitory component.

Roots of $\phi_s$ ( $z^s$ ) , Letting $\phi$ denote the real positive root of $(-\phi_s)^{1/s}$ , the polynomial $\phi_s(z)$ can be rewritten as $(z-\phi)(z^{s-1} + \phi z^{s-2} + \phi^2 z^{s-3} + \ldots + \phi^{s-1})$.

- when $\phi \geq k$ , the AR root $(1 - \phi B)$ is assigned to the trend; the other (s-1) roots to the seasonal component.
- when $\phi < k$ , roots are assigned to the transitory component.

(Note: The parameters k and $\varepsilon$ can be controlled by the user.)

The factorization of $\Phi(B)$ can be rewritten as

$$\Phi(B) = \phi_p(B)\phi_s(B)\phi_c(B) ,$$

where $\phi_p(B)$ , $\phi_s(B)$ and $\phi_c(B)$ are the AR polynomials with the trend, seasonal, and transitory roots, respectively. Let P and Q denote the orders of the polynomials $\Phi(B)$ and $\theta(B)$ in (6):

a) **Consider first the case P ≥ Q.** A polynomial division of the spectrum (or pseudospectrum) of model (6) yields a first decomposition of the type

$$\frac{\theta(B)}{\Phi(B)} a_t = \frac{\tilde{\theta}(B)}{\Phi(B)} a_{1t} + \nu_1 \ ,$$

where the order of $\tilde{\theta}(B)$ is min (Q, P-1), and $\nu_1$ is a constant (0 if P>Q).

A partial fraction expansion of the spectrum of $[\tilde{\theta}(B)/\Phi(B)]\, a_{1t}$ yields the decomposition

$$\frac{\tilde{\theta}(B)}{\Phi(B)} a_{1t} = \frac{\tilde{\theta}_p(B)}{\phi_p(B)} \tilde{a}_{pt} + \frac{\tilde{\theta}_s(B)}{\phi_s(B)} \tilde{a}_{st} + \frac{\tilde{\theta}_c(B)}{\phi_c(B)} \tilde{a}_{ct} ,$$

where, letting $j = p, s, c$, we have order $(\tilde{\theta}_j) \leq$ order$(\phi_j)$ . If $\tilde{g}_j(\omega)$ denotes the spectrum of $[\tilde{\theta}_j(B)/\phi_j(B)]\, \tilde{a}_{jt}$, let

$$\nu_j = \min \{ \tilde{g}_j(\omega) : 0 \leq \omega \leq \pi \} ;$$

Imposing the canonical condition

$$g_j(\omega) = \tilde{g}_j(\omega) - \nu_j ,\ j = p, s, c ,$$

$$\nu = \nu_1 + \sum_j \nu_j ,$$

the spectrum of the final components are obtained. Factorizing these spectra, the models for the components:

$$\phi_p(B)\, p_t = \theta_p(B)\, a_{pt}$$

$$\phi_s(B)\, s_t = \theta_s(B)\, a_{st}$$

$$\phi_c(B)\, c_t = \theta_c(B)\, a_{ct}$$

$$u_t = \text{white noise } (0, \nu)$$

are obtained (the spectral factorization algorithm is described in Maravall and Mathis (1994)). All components have balanced models, in the sense that the order of the AR polynomial equals that of the MA one.

b) **When (Q>P)**, the decomposition proceeds as follows.

A first decomposition is performed, whereby

$$\text{ARIMA}(P, Q) = \text{ARIMA}(P, P-1) + \text{MA}(Q-P) \ .$$

The first component falls under case a), and hence can be decomposed in the previous way. Let this decomposition be, in general,

$$\text{ARIMA}(P, P-1) = p_t + s_t + c_t + u_t$$

where $p_t$, $s_t$, $c_t$ and $u_t$ denote the trend-cycle, seasonal, transitory, and irregular component. The MA(Q-P) component, which represents stationary short-term deviations, is added to the transitory component. The series is decomposed then, into a balanced trend-cycle model, a balanced seasonal model, a top-heavy transitory model, and a white-noise irregular. The first three components are made canonical (i.e., noise free).

As a general rule, it is recommended that balanced models be favoured, since they tend to display good decomposition properties. Models for which Q is much larger than P are discouraged because the excess MA structure may provoke awkward, on occasion nonadmissible, decompositions.

Example: The monthly model

$$(1+.4B-.32B^2)\,\Delta\Delta_{12}\,x_t = \theta(B)\,a_t\ ,$$

with $\theta(B)$ of order Q=16 ( > P = 15), would decompose as follows. Factorizing the AR(2), it can be rewritten as $(1-.4B)(1+.8B)$, and hence the first factor goes to the transitory component (by default, k = .5), and the second factor to the seasonal component (a peak for $\omega = \pi$). Therefore, the models for the components will be of the type:

Trend: $\Delta^2 p_t = \theta_p(B)\,a_{pt}$

Seasonal: $(1+.8B)\,S\,s_t = \theta_s(B)\,a_{st}$

Transitory: $(1-.4B)\,c_t = \theta_c(B)\,a_{ct}$

Irregular: White noise.

The orders of the polynomials $\theta_p(B)$, $\theta_s(B)$, and $\theta_c(B)$ would be 2, 12, and 2, respectively.

Examples of straightforward TRAMO-SEATS applications can be found in Kaiser and Maravall (2001a), Maravall and Sanchez (2000), and Maravall (2000); extensions of TRAMO-SEATS to the problem of quality control of data and business-cycle estimation are described in Luna and Maravall (1999) and Kaiser and Maravall (2001b).

**Final Remark**

TRAMO and SEATS are intensively used at (and recommended by) Eurostat (see Eurostat (1996, 1998, 1999, 2000)) and at the European Central Bank, (see European Central Bank (1999, 2000)) together with X12ARIMA. They are used at many central banks, statistical offices, and other economic agencies in and outside Europe, both for in-depth treatment and analysis of important series (see, for example, European Central Bank (2000), Banco de España (1994), Banca d'Italia (1999), or Banco de Reserva de El Salvador (1998), for careful treatment of groups of (most often) economic indicators (some Spanish examples, in the public and private sectors, are found in Ministerio de Economia y Hacienda (2000), Instituto Nacional de Estadistica (1997), Analistas Financieros Intemacionales (1998), Expansión (1998), Agencia Tributaria (1999), or Banco Santander Central Hispano (2000)), or for relatively large scale use (see, for example, Eurostat (1995, 1997), ISTAT (2000), Statistics Sweeden (2000), or National Bank of Belgium (2001)). The main applications are short-term forecasting and monitiring, seasonal adjustment, trend-cycle estimation, interpolation, detection and correction of outliers, detection of errors and anomalies in data, and estimation of special effects.

### 1.3 PROGRAM TERROR

TERROR ("TRAMO for errors"), is an application to quality control of data; in particular, to the detection of errors in reported (time series) data. Program TERROR is designed to handle large sets of time series with a monthly or lower frequency of observation, and specifies a particular configuration of TRAMO, that will be applied to each time series, mostly based on the automatic model identification and outlier detection and correction procedures.

For each series, the program automatically identifies an ARIMA model and detects and corrects for several types of outliers. (It also interpolates missing observations if there are any.) Next, the one-period-ahead forecast of the series is computed and compared with the new observation (this new observation is not used for estimation). In brief, when the forecast error is, in absolute value, larger than some a priori specified limit, the new observation is identified as a possible error. More details are provided in Caporello and Maravall (2000), and Luna and Maravall(1999).

### 1.4 PROGRAM TSW

Program TSW is a Windows version of TRAMO-SEATS, with a few modifications, developed by Gianluca Caporello and Agustín Maravall. Besides the usual text format for the input file, the program can access and deposit files in EXCEL, and contains several new facilities, in particular, summary tables with the main series that are output of the two programs (deterministic corrections and stochastics components with their forecasts), summary results for both programs, and a small data base facility to help routine applications. The program contains an on-line help facility with the meaning of all parameters.

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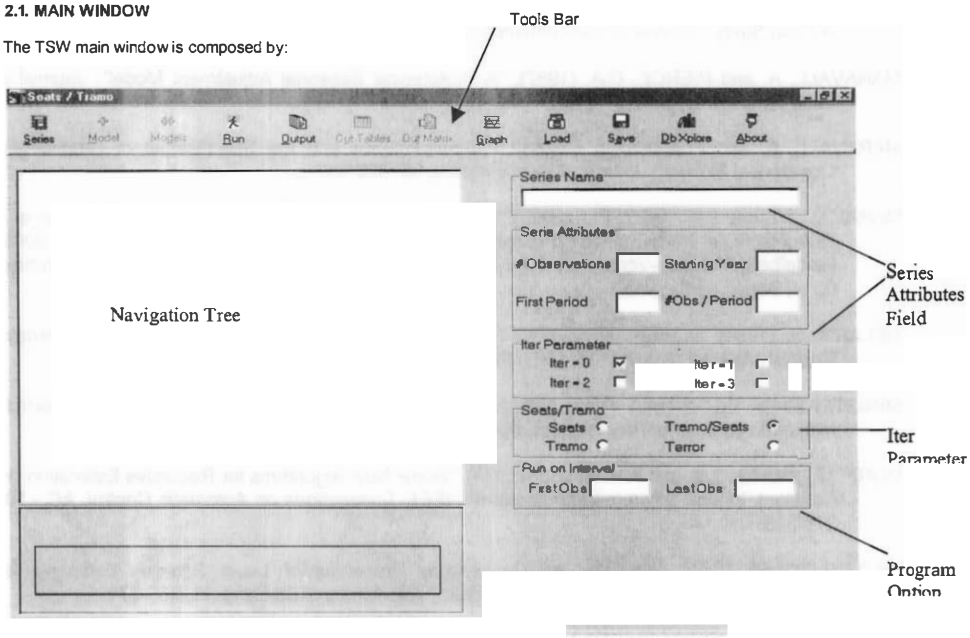
## 2. USER INSTRUCTIONS

### 2.1. MAIN WINDOW

The TSW main window is composed by:




- Tools Bar
- Navigation Tree
- Series Attributes fields
- Iter Parameter
- Programs Option

<u>Tools Bar</u>

The Tools Bar contains the following buttons:

✓ **Series** permits to load a single series file or a list of files.

✓ **+ Model permits** to specify an input model for the selected series.

✓ **++ Model** permits to specify an input model (the same) for all the series loaded in the navigation tree.

✓ **Run** executes Seats/Tramo

✓ **Output** visualizes the standard Seats/Tramo output files.

✓ **Graph** shows the graphs computed by the programs.

✓ **Save** permits to freeze the navigation tree saving it on a binary proprietary output file (*.gbt).

✓ **Load** loads a working tree saved.

✓ **DbXplore** is the manager of a small data base (Db ) facility.

✓ **About** shows the release and authors information of the program.

Series Attributes

- ✓ Name
- ✓ #of Observations (NZ; it includes missing values)
- ✓ Starting Year
- ✓ First Observation Period (ex: for monthly series, 1 if Jan., 2 if Feb,...)
- ✓ #obs/period (12 if monthly, 4 if quarterly,...)

Iter Parameter:

| | | |
|---|---|---|
| Iter | = 0 | One series, one model specification (usual case). |
| | = 1 | One series, several model specifications. |
| | = 2 | Many series, one model specification common to all of them (the specification can simply be an automatic procedure). |
| | = 3 | Several series, one model specification for each series. |

The last 3 cases will be explained below; for now we proceed with Iter = 1.

Program option:

| | |
|---|---|
| Seats: | Only SEATS will be executed |
| Tramo: | Only TRAMO will be executed |
| Tramo/Seats: | Both programs will be executed (the usual case). |
| Terror: | Program TERROR will be executed |

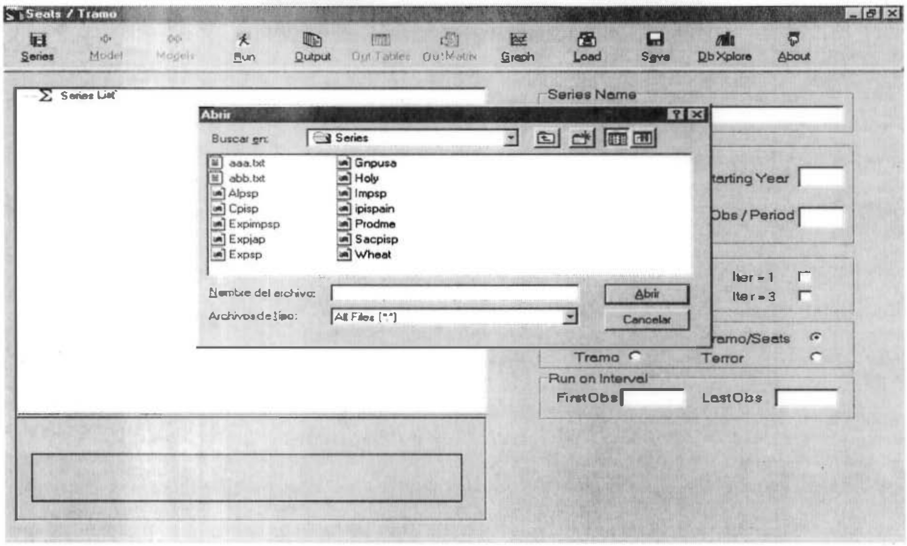
Run on Interval:

For a series with observations t = 1,....,NZ, it is possible to select an interval of the sample period, and apply TSW only to the interval. The interval starts at observation " First Obs", and ends at " Last Obs ".

## 2. 2. LOADING A SERIES

Series Button

Clicking on the button series the program opens a standard dialog window in order to select an input file which contains the series. The following screen is displayed



The list that appears is the names of the series in the directory PROGRAM FILES\TSW\SERIES.

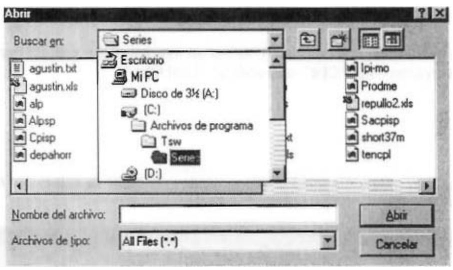
TSW accepts two series file format: text or Excel. The first line of the file should contain the name of the series. The second line should contain four numbers: Number of observations, starting year, starting period of the year, and number of observations per year (format free). The following lines should contain the numerical values of the series (format free and read from left to right). Missing values are entered as -99999.

One or many series can be loaded. We shall look first at the case of ONLY ONE SERIES.

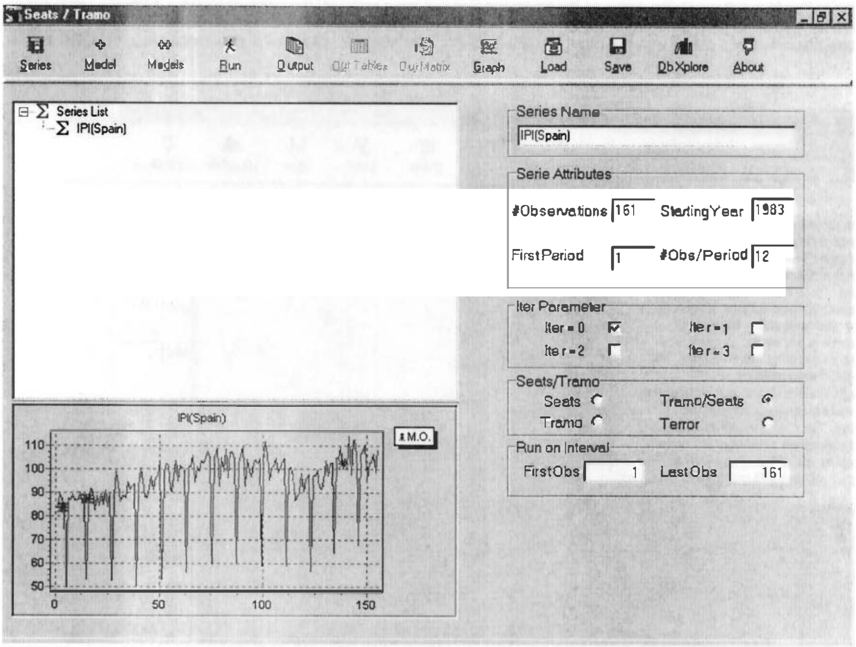
* If the series of interest appears in the screen,
  - - clicking with the right mouse button (r.m.b), the file can be opened and edited.
  - - clicking with the left mouse button (l.m.b), the series is loaded to the Navigation Tree.

  (in what follows, when no button is specified, it refers to the l.m.b)

* If the series of interest is in some other directory, by clicking in SERIES one can move to the other directories in the usual Windows manner, and select the series by clicking on it.



The selected series is incorporated to the Navigation Tree, the Main window shows

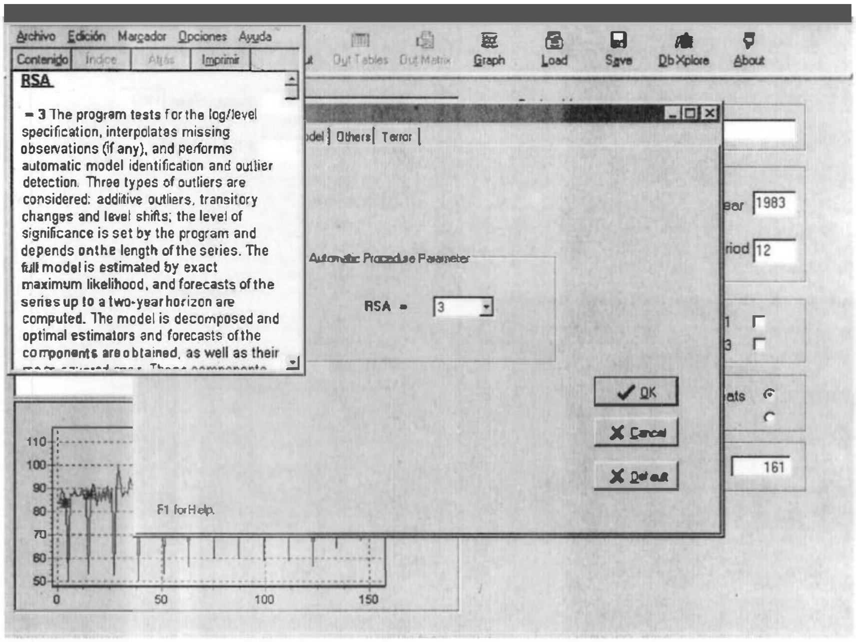


2.3. MODEL SPECIFICATION

Having selected a series, one proceeds to enter the model.

**+Model Button**

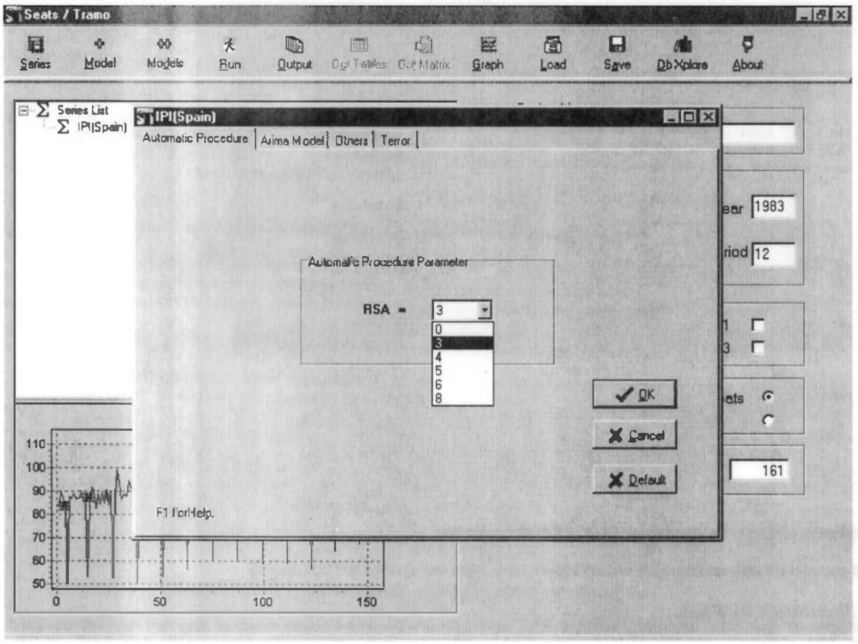
Clicking the button (it is active only if a series on the navigation tree has been selected) the program shows a Tabsheet Set Window structure (it has the appearance of notebook dividers) which permits to set the Seats/Tramo input parameters.
The window contains three pages with the **input parameters**. For their meaning, click in the parameter entry, then use **F1** for **Help**



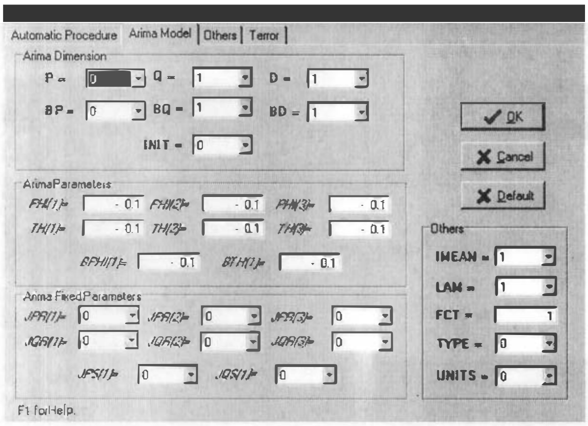

The complete description of the parameters is contained in the next section.

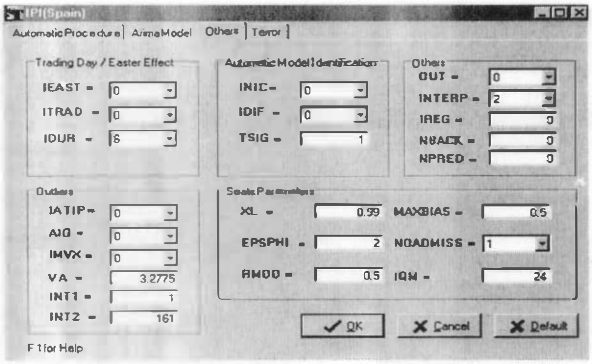
**The Cancel Button** permits to exit from the form without saving the model. The **Default button** sets the parameter values to their Default. The **OK button** exits and saves the model associating it to the selected series.

The first page contains the purely **Automatic Procedure** controlled by the parameter RSA.




The second page contains the **ARIMA Model parameters**





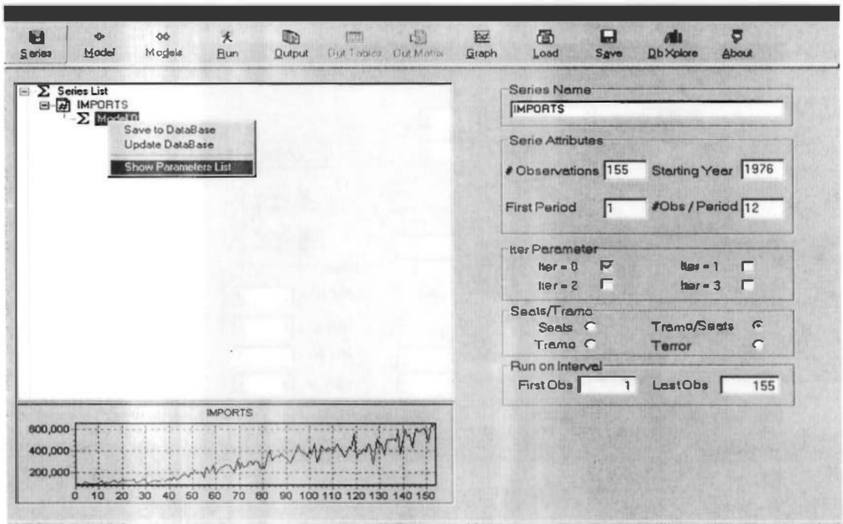

The fourth page contains the parameters for a TERROR application.

When all parameters (different from the default option) have been set, click on the **button OK**

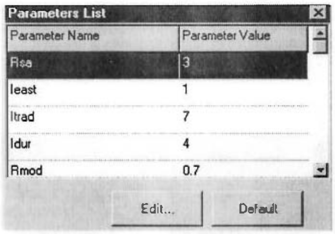
Note on the Automatic procedure:
The automatic configurations associated with the RSA parameter are described below; however they can be modified: after setting the RSA parameter, enter the desired values of the modified parameters (if the value desired is the default one, you still have to reenter the parameter).

**Checking Input Parameters**

Once the input parameters specifying the model have been entered, by selecting " $\sum Model\,0$ " in the Navigation Tree and clicking the right mouse button, one has the option **Show Parameters List**.

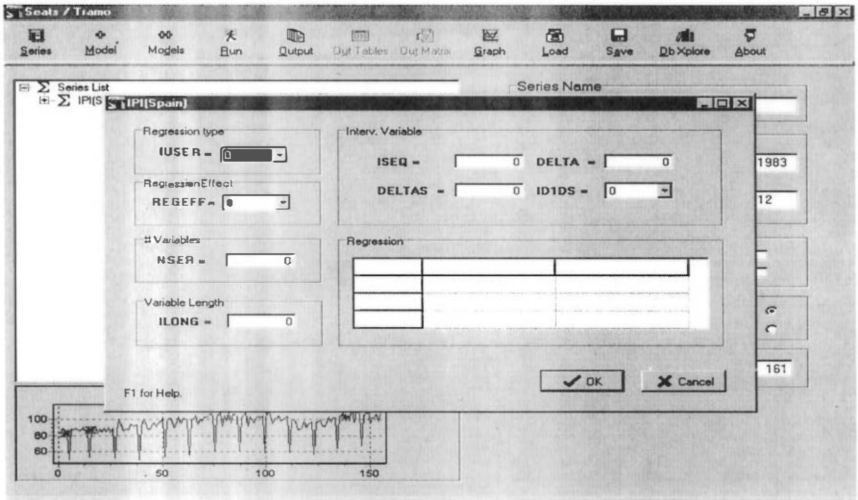


Clicking on this option, a screen with only the parameters that have been entered is displayed. ( the other parameters, that remain at their default values, are not included ).




**2.4 REGRESSION VARIABLES**

When, on page 3 ("Others..."), IREG = k > 0, a new window is displayed that will set the regression variables and their associated parameters.

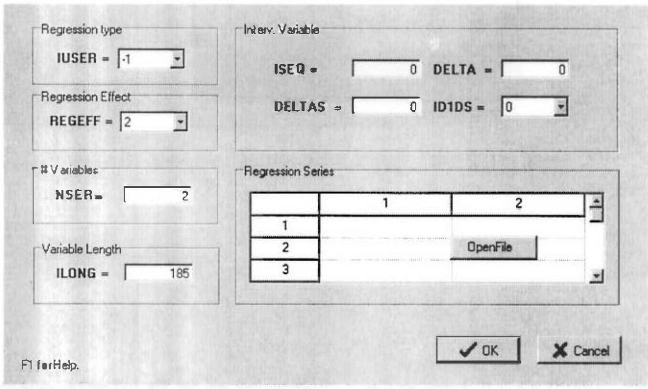


– When **IUSER = 1** the variable is entered **by the user**, observation by observation. REGEFF determines to which component in SEATS the regression variable will be assigned, NSER = 1, and, as in all cases,

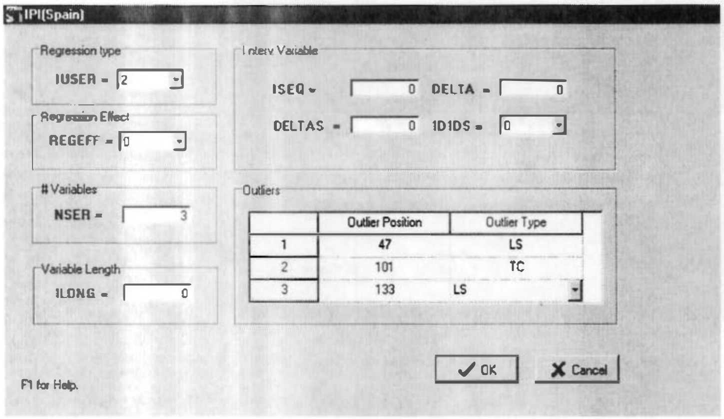
ILONG = NZ + FORECAST HORIZON

(the regression variable should cover the forecasting period). Clicking inside the "Regression" field, the cells for entering the variable become visible.

– When **IUSER = - 1**, the regression variable(s) is (are) read **from a file**. The file should be a matrix with ILONG rows and k columns. Each column represent a regression variable. Setting NSER = k and the values of REGEFF and ILONG, clicking with the r.m.b. inside the "Regression" field, and then on the "OpenFile" command, a window is opened that allows us to load the file from the directory where it is contained.



- When **IUSER = 2**, k outliers are fixed (k = 1, 2, ...). Only NSER = k needs to be entered, and clicking in the blank field, the following screen appears.



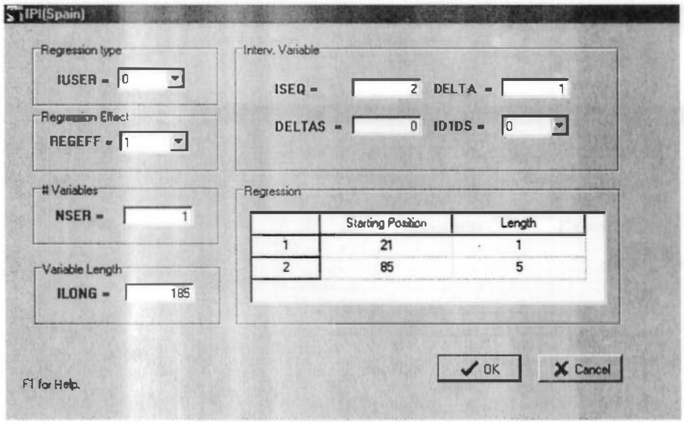

Each outlier is entered in a row containing two numbers. The first one indicates the position of the outlier (observation number), and the second one the type of outlier (AO: Additive Outlier; TC: Transitory Change; LS: Level shift).

- When **IUSER = - 2** the regression variable contains an array with **holidays**, that will be combined with the Trading Day variable. NSER and ILONG need to be set, and clicking in the blank field, the holidays can be entered by the user, or, if the r.m.b. is clicked, read from a file in a directory.

- When IUSER = 0 the regression variable will be an **intervention variable** built by the program. Each intervention variable has to be entered as a separate regression variable. After setting REGEFF, NSER=1, and ILONG, the parameter ISEQ= k indicates that the intervention variable will contain k sequences of ones. DELTA = d would indicate that the operator 1/(1-d **B**) will be applied to these sequences of ones. DELTAS = $d_s$ that the operator $1/(1 - d_s B^s)$ will be applied to the sequences of ones, and ID1DS = 1 that the operator $1/\nabla\nabla_s$ will be applied to the sequences of ones. Clicking inside the blank area, the sequences of ones can be entered. The first column contains the starting position of the sequence of ones, and the second column the length of the sequence.

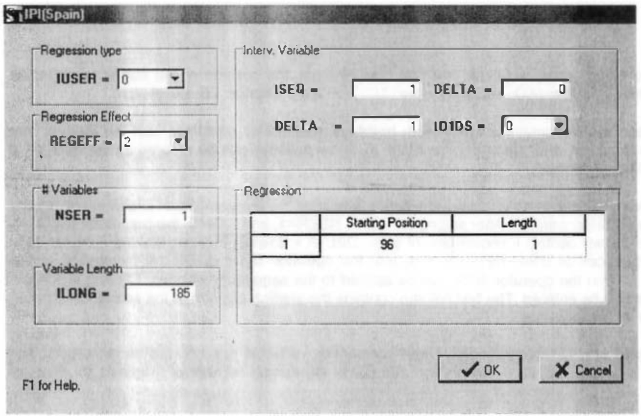
**EXAMPLE**: Assume a monthly series of a 161 observations. Three intervention variables are included as regressors. For each intervention variable, NSER = 1, and ILONG = 161 + 24 = 185 (24 is the default number of forecasts for monthly series).

The screen with the input data for the **first variable** is set as



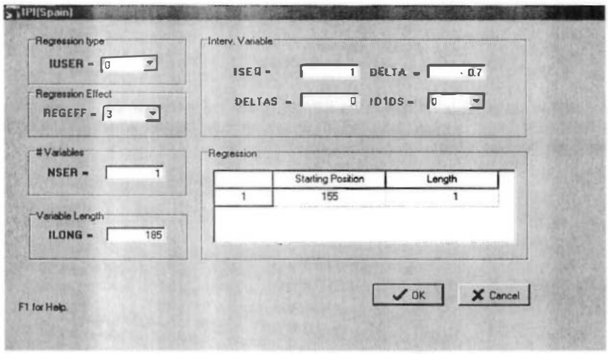

It indicates that the variable presents a level shift at observation 21, and that, starting at period 85, there is a ramp effect lasting 5 periods. The variable will be assigned to the trend-cycle component in SEATS (REGEFF=1).

The screen for the second variable is set as



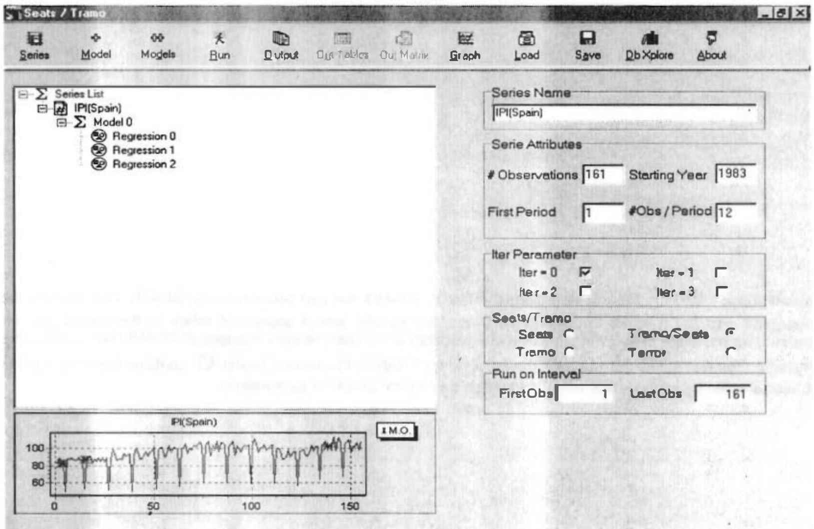
It indicates that the intervention variable consists of isolated spikes every 12 months, starting at period 96. It will be centered by SEATS and assigned to the seasonal component(REGEFF=2); the mean effect will go to the trend-cycle.

The screen for the third variable is set as




It indicates that, starting at period 155, there will be a transitory effect, similar to a transitory change but with alterning signs. In SEATS it will be assigned to the irregular component (REGEFF=3).

The full Navigation Tree for the example would be

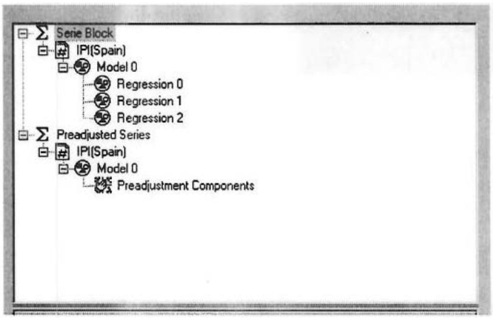


In general, the **Navigation Tree** has the classical Windows explore structure. It is possible to remove series/models (Canc Key), select a series (clicking on it), expand or collapse the tree structure, rename a series (selecting and clicking on it), show the associated model (double click on a model tree node) and perhaps modify it, show the regression variables (double click on a Regression variable tree mode) and perhaps modify or remove it.

## 2.5. EXECUTION OF THE PROGRAMS AND OUTPUT FILES

### 2.5.1 Execution

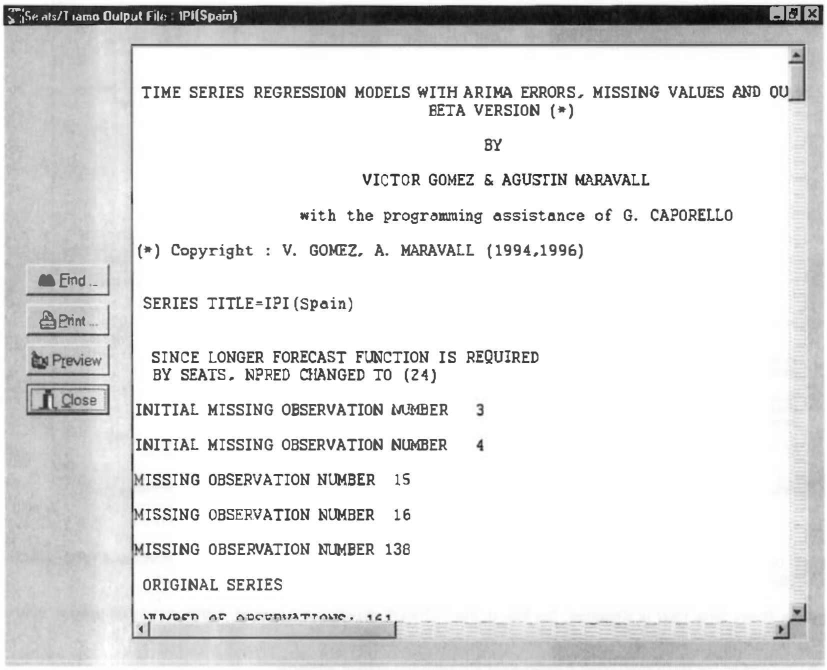
Once the model has been specified, to execute TRAMO and SEATS, mark the name of the series in the Navigation Tree, and click in the **RUN icon** (when running, the program shows an Hour Glass). When estimation is finished, the (expanded) Navigation Tree looks as follows.




The part above " $\ominus - \sum$ **Preadjusted Series**" refers to TRAMO; the part below refers to SEATS. The first time the series name appears it refers to the original series; the second time it appears it refers to the preadjusted (or linearized) series, and the series in the graph at the bottom of the main window changes (if TRAMO has made some correction). The first Model $\oslash$ contains the input file for TRAMO, the second Model $\oslash$ contains the input file that has been created for SEATS (with only 2 pages and a reduced number of parameters).

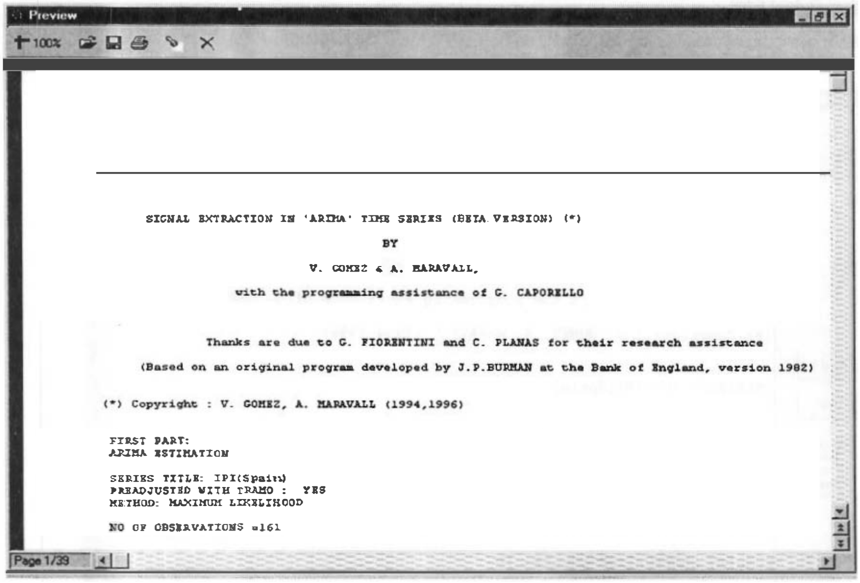
### 2.5.2 Main Output Files

When the first series name is marked, clicking on the OUTPUT icon, the output file of TRAMO is obtained




It is possible to navigate on the file using the scroll bar, to search for a word in the file (button **Find**), to obtain a **preview** or to **print** the full file.

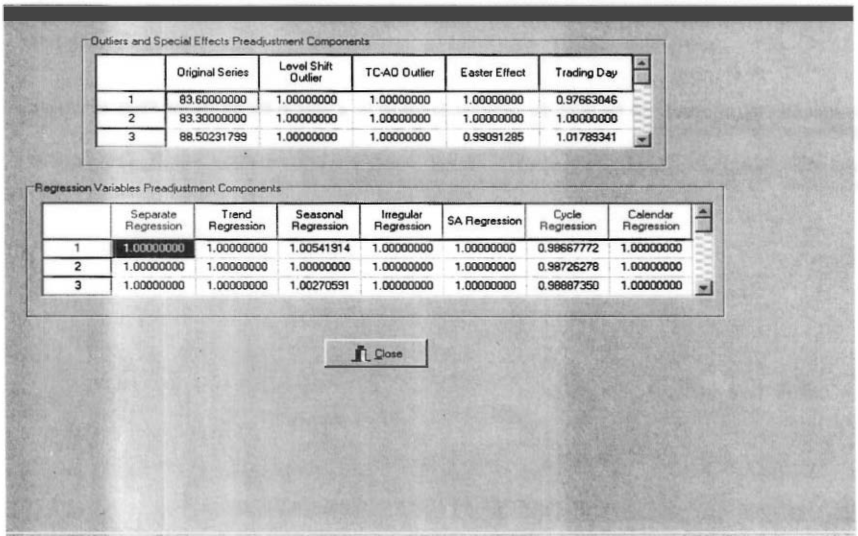
When the series name appearing the second time is marked, clicking on the **OUTPUT Icon**, the output file of **SEATS** is obtained. The same facilities are available; the following screen shows the preview.




The two output files can also be found in the directories PROGRAM FILES\TSW\OUTPUT\TRAMO and PROGRAM FILES\TSW\OUTPUT\SEATS, both under the same name: *"seriesname.out"*.

**Warning**: Every time TSW is initialized, the files in the OUTPUT directory are erased. If they are to be used in later sessions, they should be stored in some other directory before exiting.

Finally, by clicking on **Preadjustment Component** the following screen appears




| | Original Series | Level Shift Outlier | TC-AO Outlier | Easter Effect | Trading Day |
|---|---|---|---|---|---|
| 1 | 83.60000000 | 1.00000000 | 1.00000000 | 1.00000000 | 0.97663046 |
| 2 | 83.30000000 | 1.00000000 | 1.00000000 | 1.00000000 | 1.00000000 |
| 3 | 88.50231799 | 1.00000000 | 1.00000000 | 0.99091285 | 1.01789341 |

| | Separate Regression | Trend Regression | Seasonal Regression | Irregular Regression | SA Regression | Cycle Regression | Calendar Regression |
|---|---|---|---|---|---|---|---|
| 1 | 1.00000000 | 1.00000000 | 1.00541914 | 1.00000000 | 1.00000000 | 0.98667772 | 1.00000000 |
| 2 | 1.00000000 | 1.00000000 | 1.00000000 | 1.00000000 | 1.00000000 | 0.98726278 | 1.00000000 |
| 3 | 1.00000000 | 1.00000000 | 1.00270591 | 1.00000000 | 1.00000000 | 0.98887350 | 1.00000000 |

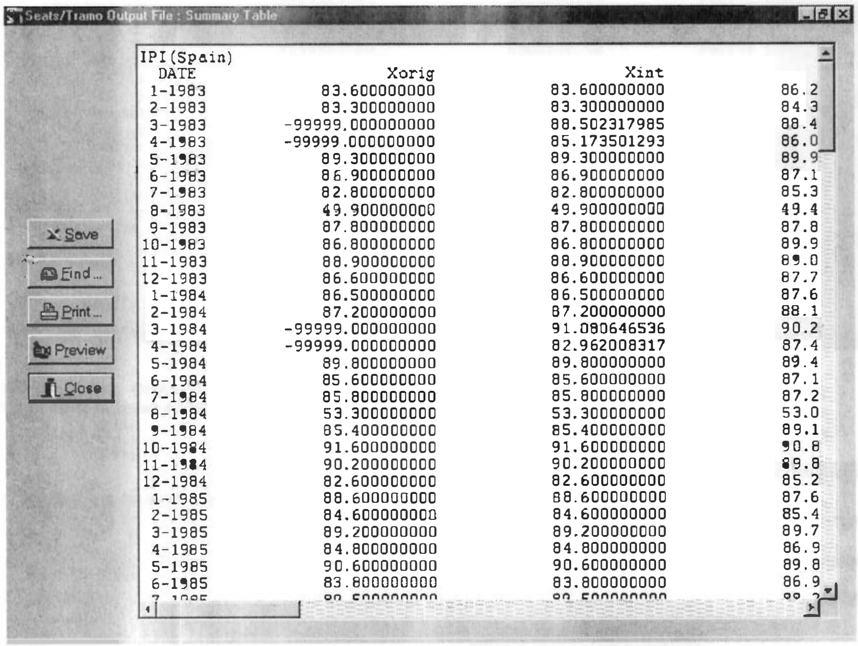
The top part contains the columns:
*Original Series*
*Level Shift Outliers*
*Transitory Outliers* (sum of AO and TC outliers)
*Easter effect*
*Trading Day Effect*

The bottom part contains the Regression Variable Effects classified according to the component they will be assigned to in SEATS.

### 2.5.3 Out-Tables ( output series )

- When the first series name is marked, clicking on the **OUT-TABLES icon**, a file is displayed that contains the variables that are produced by TRAMO. They cover the sample period (1: NZ) plus the forecasting period (NZ + 1: NZ + FH), where FH = forecast horizon. The columns contain the following variables

1st column: *Date of observation*
2nd column: *Original series*
3rd column: *Interpolated series*
4th column: *Linearized series*
5th column: *Deterministic mean*
6th column: *Trading day effect*
7th column: *Easter effect*
8th column: *Additive Outliers*
9th column: *Transitory Changes*
10th column: *Level shifts*

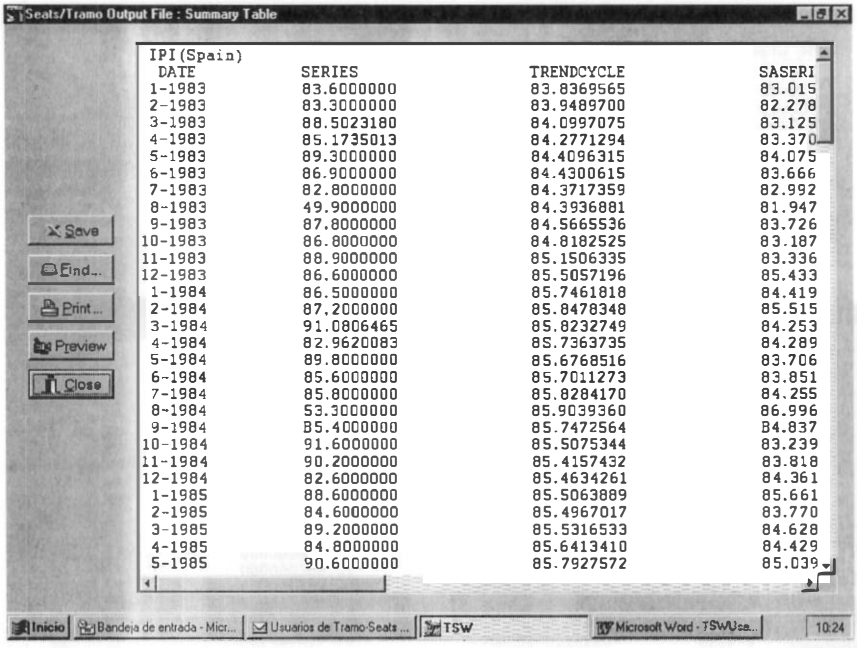



IPI(Spain)

| DATE | Xorig | Xint | |
|---|---|---|---|
| 1-1983 | 83.600000000 | 83.600000000 | 86.2 |
| 2-1983 | 83.300000000 | 83.300000000 | 84.3 |
| 3-1983 | -99999.000000000 | 88.502317985 | 88.4 |
| 4-1983 | -99999.000000000 | 85.173501293 | 86.0 |
| 5-1983 | 89.300000000 | 89.300000000 | 89.9 |
| 6-1983 | 86.900000000 | 86.900000000 | 87.1 |
| 7-1983 | 82.800000000 | 82.800000000 | 85.3 |
| 8-1983 | 49.900000000 | 49.900000000 | 49.4 |
| 9-1983 | 87.800000000 | 87.800000000 | 87.8 |
| 10-1983 | 86.800000000 | 86.800000000 | 89.9 |
| 11-1983 | 88.900000000 | 88.900000000 | 89.0 |
| 12-1983 | 86.600000000 | 86.600000000 | 87.7 |
| 1-1984 | 86.500000000 | 86.500000000 | 87.6 |
| 2-1984 | 87.200000000 | 87.200000000 | 88.1 |
| 3-1984 | -99999.000000000 | 91.080646536 | 90.2 |
| 4-1984 | -99999.000000000 | 82.962008317 | 87.4 |
| 5-1984 | 89.800000000 | 89.800000000 | 89.4 |
| 6-1984 | 85.600000000 | 85.600000000 | 87.1 |
| 7-1984 | 85.800000000 | 85.800000000 | 87.2 |
| 8-1984 | 53.300000000 | 53.300000000 | 53.0 |
| 9-1984 | 85.400000000 | 85.400000000 | 89.1 |
| 10-1984 | 91.600000000 | 91.600000000 | 90.8 |
| 11-1984 | 90.200000000 | 90.200000000 | 89.8 |
| 12-1984 | 82.600000000 | 82.600000000 | 85.2 |
| 1-1985 | 88.600000000 | 88.600000000 | 87.6 |
| 2-1985 | 84.600000000 | 84.600000000 | 85.4 |
| 3-1985 | 89.200000000 | 89.200000000 | 89.7 |
| 4-1985 | 84.800000000 | 84.800000000 | 86.9 |
| 5-1985 | 90.600000000 | 90.600000000 | 89.8 |
| 6-1985 | 83.800000000 | 83.800000000 | 86.9 |

When the series name marked is the one appearing the second time, clicking on the **OUT-TABLES icon**, a file is displayed with the series produced by SEATS, extended over the forecasting period. The columns contain the following series:

1[st] column: *Original series*
2[nd] column: *Final Trend-cycle*
3[rd] column: *Final Seasonally Adjusted series*
4[th] column: *Final seasonal component (or factor)*
5[th] column: *Calendar effect* (Trading Day effect + Easter effect + Holiday effect)
6[th] column: *Transitory-irregular component* (combined effect of transitory and irregular components or factors)
7[th] column: *Preadjustment component*
8[th] column: *Extended residuals* (computed by SEATS).




IPI(Spain)

| DATE | SERIES | TRENDCYCLE | SASERI |
|---|---|---|---|
| 1-1983 | 83.6000000 | 83.8369565 | 83.015 |
| 2-1983 | 83.3000000 | 83.9489700 | 82.278 |
| 3-1983 | 88.5023180 | 84.0997075 | 83.125 |
| 4-1983 | 85.1735013 | 84.2771294 | 83.370 |
| 5-1983 | 89.3000000 | 84.4096315 | 84.075 |
| 6-1983 | 86.9000000 | 84.4300615 | 83.666 |
| 7-1983 | 82.8000000 | 84.3717359 | 82.992 |
| 8-1983 | 49.9000000 | 84.3936881 | 81.947 |
| 9-1983 | 87.8000000 | 84.5665536 | 83.726 |
| 10-1983 | 86.8000000 | 84.8182525 | 83.187 |
| 11-1983 | 88.9000000 | 85.1506335 | 83.336 |
| 12-1983 | 86.6000000 | 85.5057196 | 85.433 |
| 1-1984 | 86.5000000 | 85.7461818 | 84.419 |
| 2-1984 | 87,2000000 | 85.8478348 | 85.515 |
| 3-1984 | 91.0806465 | 85.8232749 | 84.253 |
| 4-1984 | 82.9620083 | 85.7363735 | 84.289 |
| 5-1984 | 89.8000000 | 85.6768516 | 83.706 |
| 6-1984 | 85.6000000 | 85.7011273 | 83.851 |
| 7-1984 | 85.8000000 | 85.8284170 | 84.255 |
| 8-1984 | 53.3000000 | 85.9039360 | 86.996 |
| 9-1984 | 85.4000000 | 85.7472564 | 84.837 |
| 10-1984 | 91.6000000 | 85.5075344 | 83.239 |
| 11-1984 | 90.2000000 | 85.4157432 | 83.818 |
| 12-1984 | 82.6000000 | 85.4634261 | 84.361 |
| 1-1985 | 88.6000000 | 85.5063889 | 85.661 |
| 2-1985 | 84.6000000 | 85.4967017 | 83.770 |
| 3-1985 | 89.2000000 | 85.5316533 | 84.628 |
| 4-1985 | 84.8000000 | 85.6413410 | 84.429 |
| 5-1985 | 90.6000000 | 85.7927572 | 85.039 |

The two files can be found in the directories PROGRAM FILES\TSW\OUTPUT\TRAMO and PROGRAM FILES\TSW\OUTPUT\SEATS, under the names *table-t.out* and *table-s.out*. They can also be saved as Excel files in which case they are deposited in the directory SAVED.

## 2.5.4 Summary Output and Out-Matrix

In the case ITER=0 ( one series, one input file) the files **Summaryt.txt** and **Summarys.txt** are available in OUTPUT. They contain the following summary of the TRAMO and SEATS results.

**a) Summaryt.txt** ( results from TRAMO):

**Model Fit:**

| | |
|---|---|
| Sec: | Execution time (in seconds). |
| Nz: | Number of observations in series. |
| Lam: | 0 if logs have been taken; 1 if levels. |
| Mean: | 0 if model has no mean; 1 if it has a mean. |
| p,d,q,bp,bd,bq: | orders (P, D, Q) (BP, BD, BQ), of the fitted ARIMA model. |
| SE(res): | Standard Error of Residuals. |
| Q-val: | Ljüng-Box-Pierce Q statistics for residual autocorrelation. |
| N-test: | Bowman-Shenton test for Normality of the residuals. |
| SK(t): | t-value for Ho: Skewness of residuals = 0 |

Kur(t): t-value for Ho: Kurtosis of residuals= 3
QS: Pierce Qs-test for seasonal autocorrelation in residuals. (*)
Q2: Q-statistics for autocorrelation in squared residuals.
Runs: t-test for runs (randomness) in signs of residuals.
(*) when the lag-12 autocorrelation is negative, QS is unrelated to seasonality and the value –99.99 is printed.

**ARMA Parameters**

The order is the following.
Estimate of the regular AR polynomial $(1+\phi_1 B+\phi_2 B^2+\phi_3 B^3)$

Estimate of the seasonal AR polynomial $(1+\phi_s B^s)$

Estimate of the regular MA polynomial $(1+\theta_1 B+\theta_2 B^2+\theta_3 B^3)$

Estimate of the seasonal MA polynomial $(1+\Theta_s B^s)$

The associated t-values are also given

**Deterministic Effect ( total )**

TD: Number of Trading Day variables.
EE: Presence / absence of Easter effect.
# OUT: Total number of Outliers
AO: Number of Additive Outliers
TC: Number of Transitory Change outliers.
LS: Number of Level Shift outliers.
REG: Number of ( additional) regression variables.
MO: Number of missing observations

**Calendar Effect**

TD1, .... , TD6: Estimators of Trading Day variable effects.
LY: Estimator of Leap-Year effect.
EE: Estimator of Easter effect.

The associated t-values are also provided.

**Outliers**

Detected and corrected outliers are listed; first Additive Outliers, then, Transitory Changes, and finally, Level Shifts. For each outlier, the date and assoc. t-value are given.

**Regression variables**

The regression variables ( their total number equal to IREG ) are listed in the order in which they were entered. The coefficient estimators and assoc. t-values are printed.

**b) Summarys.txt** ( results from SEATS):

**General**

Preadj. : Preadjusted with TRAMO ( Y / N )
Model Changed: Model passed by TRAMO has been changed by SEATS ( Y / N )
Approx. to NA: The model used to decompose the series is an approximation to an original model that provided a non-admissible decomposition. ( Y / N ).
New Model: When the model from TRAMO has been changed by SEATS, the new model orders are printed in these columns.
SD(at): Standard Deviation of the ( recomputed and ) extended SEATS residuals.
Spect. factor: Spectral Factorization that provides the model decomposition (0 = OK / E = ERROR).
Check on ACF: Check on the comparison of variances among the theorical components, the theorical estimators, and the empirical estimates ( 0 / E ).
Determ. Compon. Mod. The stochastic SEATS component is modified by some of the deterministic effects captured by TRAMO ( Y / N ).

**Params. I**

SD( innov): Standard deviation of the component innovation. Expressed in units of the series ( logs if LAM=0 ).The components are: TC = Trend-cycle; S = Seasonal component; Tran: Transitory component; U: Irregular component; SA: Seasonally Adjusted Series.

SE est ( conc.) : Standard Error of the concurrent estimator ( TC and SA series ).

SE rev ( conc.) : Standard Error of the total revision error in the concurrent estimator ( TC and SA series ).

Convergence ( in % ): % reduction in the variance of the revision error of the concurrent estimator after 1 and 5 years of additional data are available ( T C and SA series ).

Signif. Seaso. (95 % ): number of periods per year for which seasonality is significantly different form 0 ( at the 95 % level ). Given that the estimation errors vary, significance is assessed for:

- Historical estimation (Hist.)
- Last observed year ( Prel.)
- One-year-ahead Forecast Function ( Fore.)

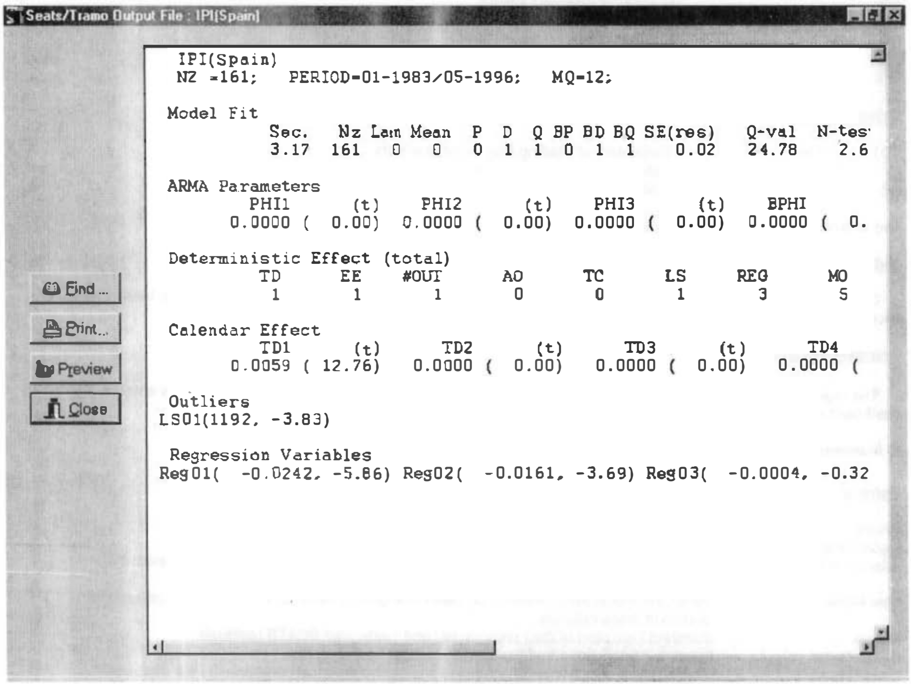
**Params. II**

SE: r. of g. : Standard Error of the rates of growth of the estimated component (in per cent points).
T11: Period-to-period rate of growth ( T C and SA series )
T1 Mq: Annual rate of growth, centered at the last available observation ( TC, SA, and Original Series ).

( For an additive decomposition, " rate-of-growth " should be replaced by "growth ", expressed in the series units ).

Diff. annual means: Average of the absolute value of the differences between the annual means of the original series, SA series, and TC ( in % ).

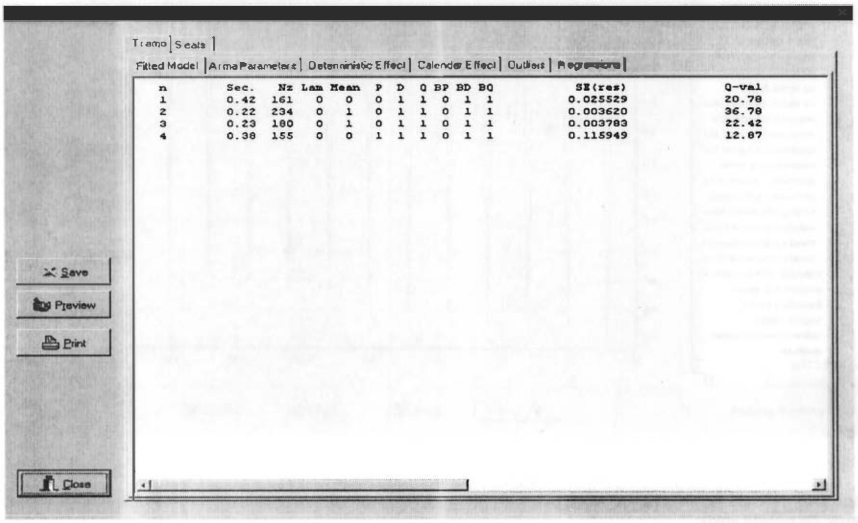
An example of a summary file is the following:



**c) Out-matrix**:

When TSW is run on an input containing many series and/or many models ( cases ITER$\neq$ 0 ) the summary.txt files are not produced. Instead, the summary results are stored under the icon **Out Matrix.**

Each matrix corresponds to one of the rows of the Summaryt and Summarys files, with the rows of the matrix referring to one of the series / models in the input. The following is an example.



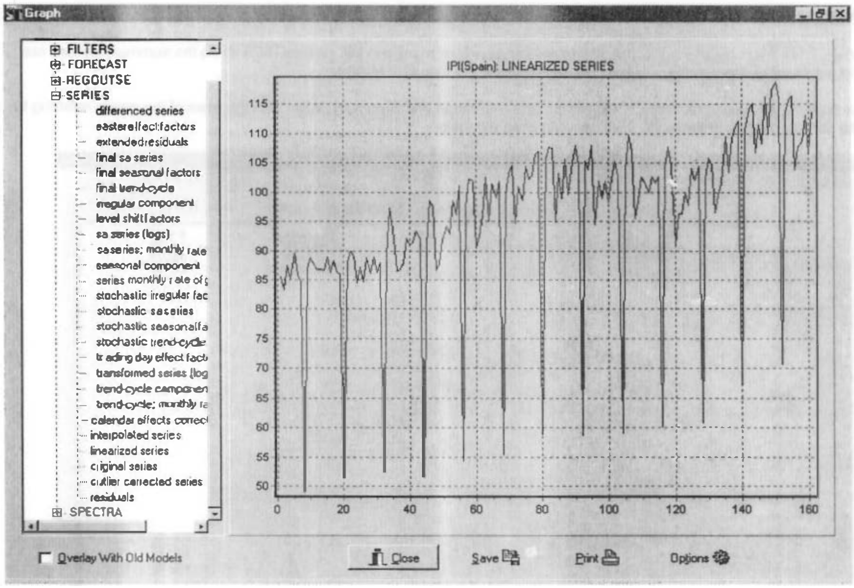

The matrices can be stored in Excel. For the case of a simple series, by setting **ITER=2**, the summary.txt files are replaced by the matrices, each one containing a simple row.

**2.6. GRAPH**

Clicking on the **GRAPH** icon a graph utility form is run, from which it is possible to visualize, print, or save the graphs produced by Seats/Tramo.

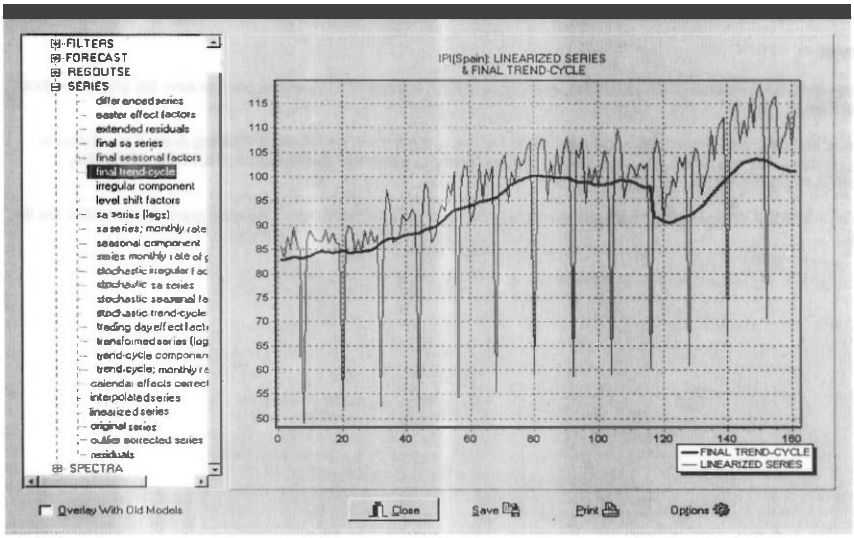
The window is divided into a **Navigation Tree** (similar to the one of the Main Window) and a **Plotting Area**. It is possible to expand or collapse the tree by clicking on it. The graphs are divided in sub-trees: **SERIES, ACF, FILTERS, SPECTRA, FORECAST**, and **REGOUTSE**-

Clicking on **+ SERIES**, for example, the graphs available show up in the Navigation Tree. The main graph funcionalities are the following:




✓ **Plot**: Select a node on the tree and double-click on it to plot the graph. A new graph will be plotted in the same way (cleaning the plotting area).

✓ **Overlay**: Select a node and click with the r.m.b.; it will show a menu with the **Item Add.** Click on it in order to overlay the selected graph with the one in the plot area.



✓ **Zoom In:** Drag a rectangle on the plot area starting from the left-top corner.

✓ **Zoom Out:** Drag a rectangle on the plot area starting from the right-bottom corner.

✓ **(x,y) coordinate:** it's possible to visualize the (x, y) coordinate of a point on the graph using the Shift+Left mouse button combination.

✓ **Graph Panning:** Clicking the r.m.b. (with the cursor on the plot area) and moving the mouse pointer will produce an horizontal or vertical scroll of the graph according to the mouse pointer movement.

✓ **Save:** Clicking on the button it is possible to save the plot area in two different formats: Bitmap (*.bmp) or Windows Meta File (*.wmf). Both are standard format and it is possible then to include the graph in your Word, Excel,... documents.

✓ **Options:** the option button gives the possibility to personalize the look of the graphs. The following options are available for each single graph in the plot area

Add points on the graph in different format: Square, Circle, Triangle etc.
Change the line format: Solid, Dash, Dot, DashDot, etc.
Change the line color.
Change the line width.

For the entire graph it is possible to:

Transform it into a 3D graph.
Change the fonts and the color of the title.
Change the printer options. It is possible to print in Portrait/Landscape and define the quantity of subplots to put in a single sheet (2 Max on the Xsheet-axis; 4 Max on the Ysheet-axis).
Change the X-Y Scale.
Backup the graphs in order to overlay them with those of a new model. To do that, click on the option **Backup**. Then run the same series with another model, click on graph and on the square **Overlay with Old Models**. Then double click on the selected graph. The graph for this and the previous model are plot.

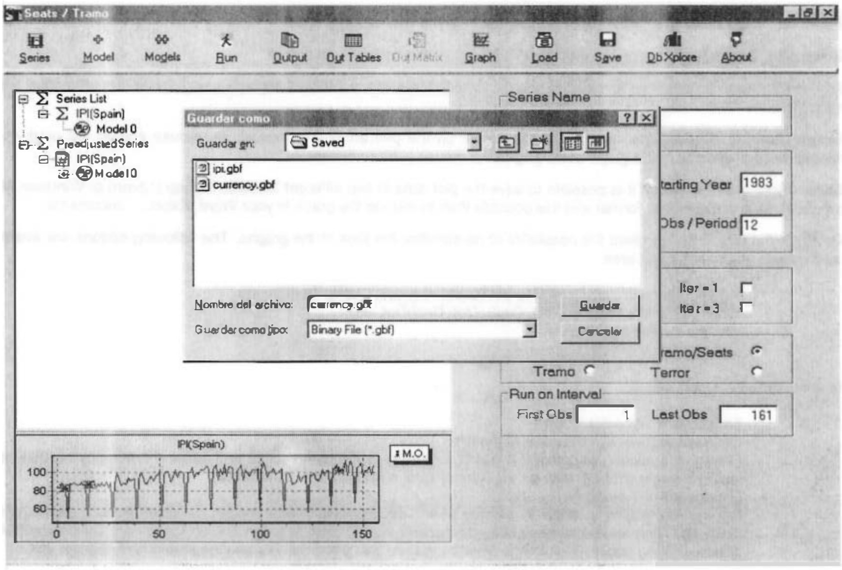
The arrays of the graphs are stored in the directory PROGRAM FILES\TSW\GRAPH

### 2.7. SAVE / LOAD

Clicking on the **SAVE icon**, the navigation tree is saved on a binary proprietary output file (*.gbf). In this way, series with their models can be saved. (The file is stored in the directory PROGRAM FILES\TSW\SAVED).

Clicking on the **LOAD icon**, the files in the directory SAVED are displayed and can be restored in the Navigation Tree. (If the saved file was moved to another working directory, it can be accessed in the usual manner).

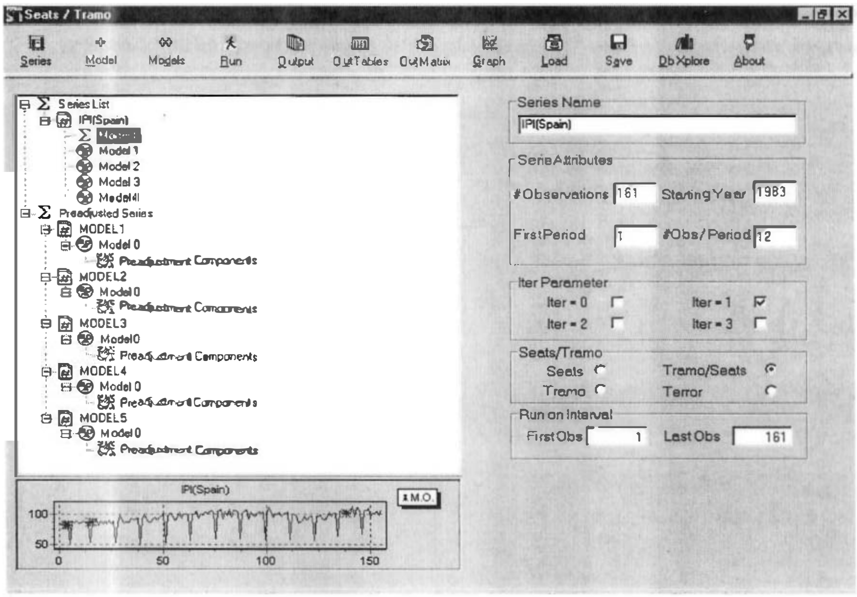
When saving as Excel files the files in out-Tables or out-Matrix, the .xls files are also stored in the SAVED directory.




## 2.8. MANY SERIES AND/OR MODELS: ITER parameter

The previous pages refer the case iter = 0, in which a single series is treated with a single model specification.

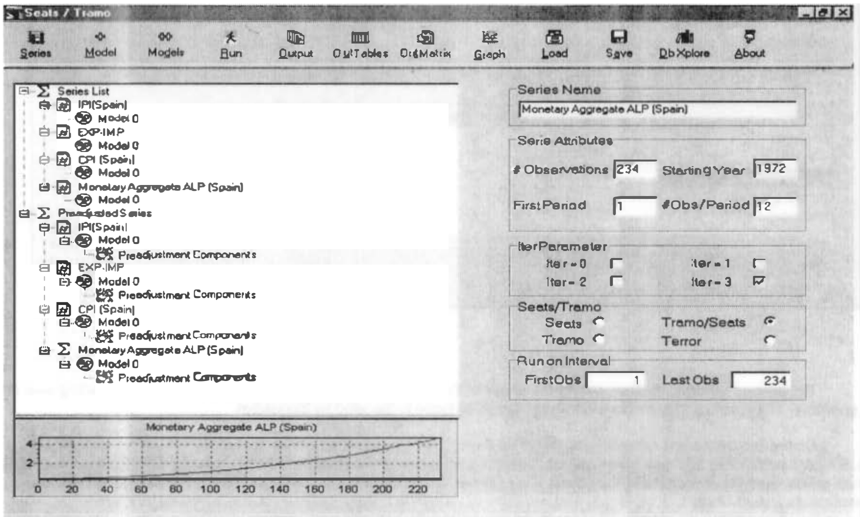
- **ITER = 1 One series; several specifications.** Having set Iter = 1 and selected a series, the models are entered by clicking on the **MODEL++** button. Clicking on **RUN**, all cases are estimated. The extended Navigation Tree looks like



Clicking on **OUTPUT**, all TRAMO-SEATS output files can be opened. Clicking on **OUT-TABLES**, the tables are listed in a single file, following the sequence MODEL 1, MODEL 2,... Clicking on **OUT-MATRIX** each matrix contains the summary results for all models. Clicking on **GRAPH** provides a selection of graphs: for each model, only the original series, final seasonally adjusted series, and final trend-cycle, as well as their forecasts, can be plot.

- **ITER = 2 Several series; one model specification**

  Having set Iter = 2, pressing the Ctrl key and clicking on the series, several series can be selected. Clicking on **MODEL++** a model specification is entered that will be common to all series (this specification can be, for example, RSA = 4; that is, automatic treatment for all). Clicking on **RUN**, all series are treated and the following Navigation Tree is produced



  Selecting one of the series and clicking on **OUTPUT**, the corresponding output file can be accessed. The button **OUT-TABLES**, woks as in the case Iter = 1 (one single file, listing first the table for the first series, then, for the second series, and so on), and **OUT-MATRIX** yields matrices of the type already described.

  **GRAPH** yields, for each series, the same selection of graphs as in the case Iter =1.

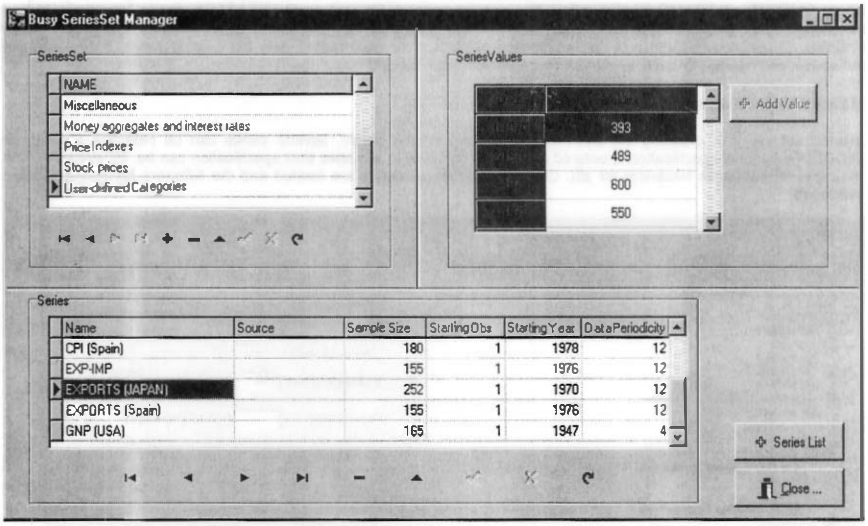
- **ITER = 3 Several series, each one with a different model**

  Having set Iter = 3, several series can be selected as in the previous case. Choosing a serie in the Navigation Tree, **MODEL** sets the model specification for that series. **RUN** executes TRAMO-SEATS; selecting a series and clicking on **OUTPUT** provides the corresponding output file. **OUT-TABLES**, **OUT-MATRIX** and **GRAPH** are as in the previous case.

**2.9 DATA BASE FACILITY: DBXPLORE**

The database facility is intended to help in routine treatment of groups of series. The series are stored together with the model specification ( orders of ARIMA model, date and type of outliers, type of TD/EE variables, set of regression variables). Then, a new observation can be added and the coefficients of the model saved updated.

Clicking in the button **DbXplore**, the user can access a DataBase screen. Three windows appear in it. The first one, **SeriesSet**, is related to the directories or records in which the DataBase is organized. When the user selects one of them, the second window, **Series**, will show the series in that directory. In the window **SeriesSet** several little buttons are available. The first button takes the user to the first directory of the DataBase. The second one takes the user to the previous directory, the third one, takes the user to the next directory, the fourth one takes the user to the last directory or record, the fifth one is used to insert a new directory, the sixth one is used to erase a directory, the seventh one permits the user to edit (change the name of the directory, the eighth one saves the change in a directory that has been edited, the ninth one cancels edition of the directory, and the last one refreshes the series of the directories.

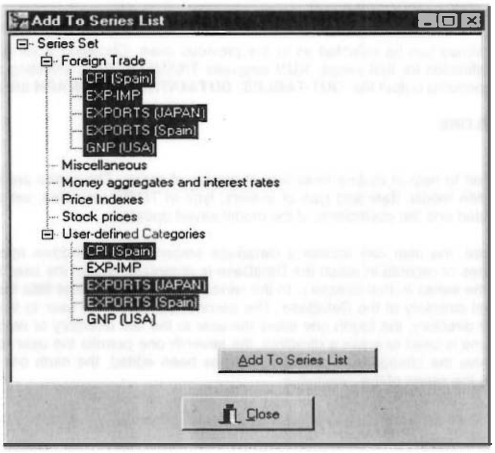



The second window, **Series**, shows the name of the series, its sample size, starting observation , starting year and data periodicy. The small buttons in this window are similar to those in the window **SeriesSet**.

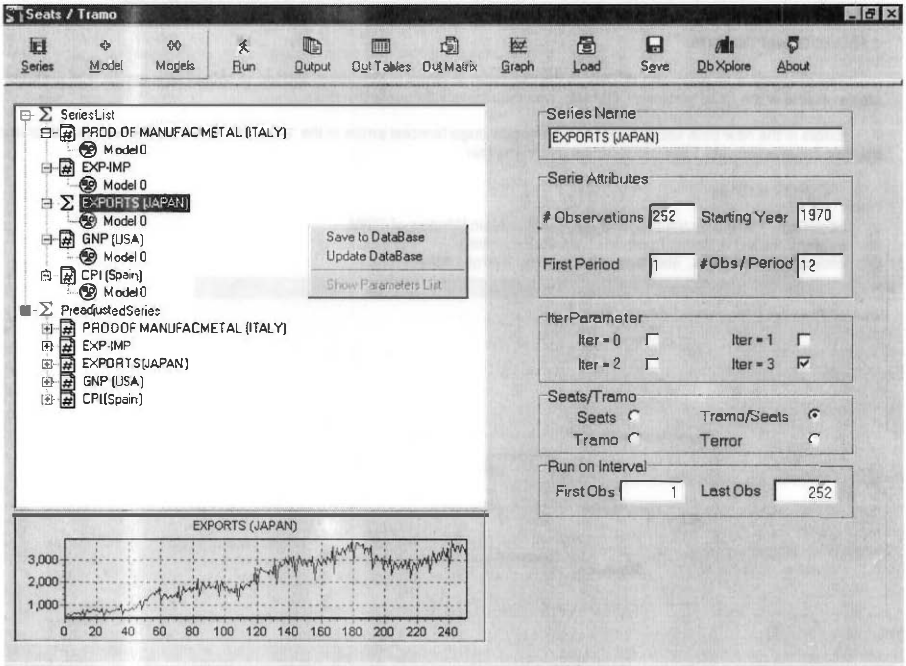
On the two tables you can navigate (scroll up,down), add records (Categories or Series), or remove and update them. It is also possible to add new series values. Some hidden tables are also defined (models, regs) which contain the model and regression namelist associated to the series. It is possible to move/clone a series to a different SeriesSet (rigth-button mouse click on Series Grid).

The third window of DbXplore is called **SeriesValue**.For the selected series, it shows the values of the series and the associated date.

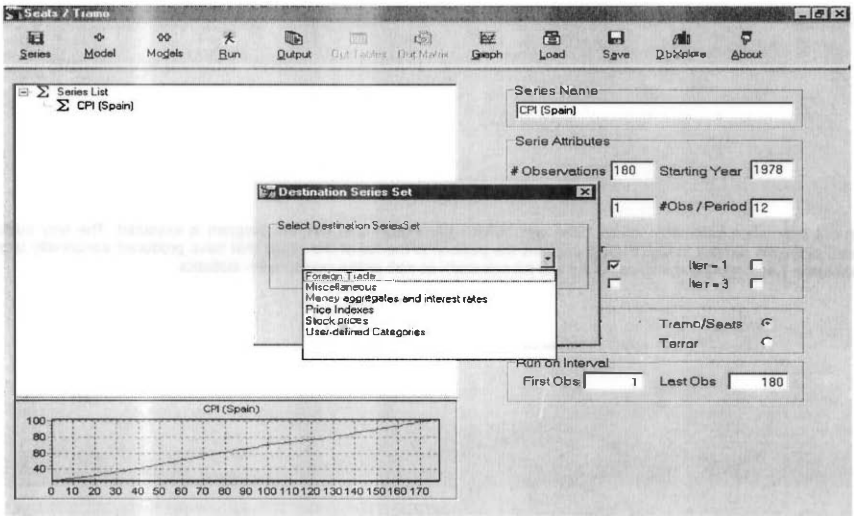
When the user wants to run in **TSW** a series in the DataBase by pressing the button **+ Series List** and selecting the series, clicking on the left button of the mouse, an option called **Add to SeriesList** will appear in the screen. This option will take the series to the navigation tree of TSW. To select more than one series, use the Control key.



Alternatively, in order to add series in the Series List to the DataBase select the series (or the entire SeriesList) and right-mouse-click. A small window shows up with two options: **Save to DataBase** and **Update DateBase**. In the first case, the user can save a new series in the DataBase, and in the second case a series in the DataBase will be updated.




After selecting the option **Save to DataBase** a new small window appears indicating the DataBase directory in which the user wants to save the series. The DataBase gives the user several predefined directories; the user can of course create additional ones.



TSW offers to the user the possibility of editing a series in the DataBase. On the bottom of the screen there are several buttons. To edit a series press the ( fourth from the right ) **Edit Record** button, then the values of the series can be modified in the SeriesValue screen by cliking on the left buttom of the mouse. A new value can be added by cliking in the **+AddValue** button. The changes can be saved by clicking the **Post Record** button, which is to the right of **Edit Record**.

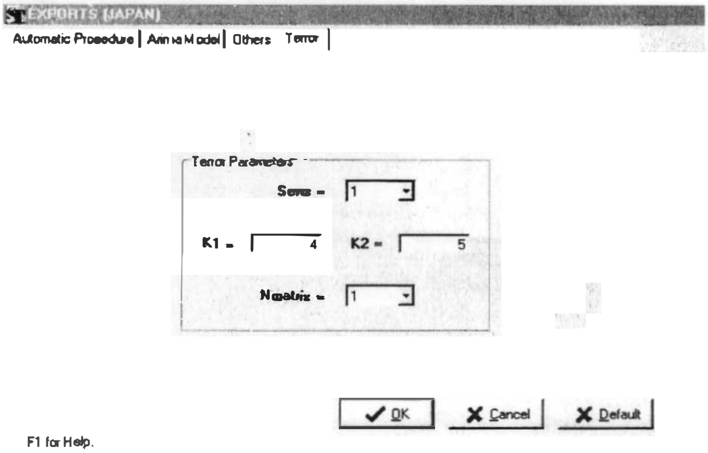
### 2.10 PROGRAM TERROR

The program is an aplication of TSW to the detection of errors in new data reported to sets of time series. The program is also available in the DOS version of TRAMO, with more complete documentation.

Errors in the new data are detected as abnormally large forecast errors in the 1-period-ahead forecast computed ignoring the new observation with TSW run in an automatic manner.

TERROR is run by:

a) choosing " Terror" as the program option in the Main Window of TSW;
b) entering the set of series ( perhaps from an Excel file );
c) clicking in **++ MODEL**, and then selecting the " Terror" sheet:




Setting the appropiate parameter values ( see next section ) and clicking in **OK**, the program is executed. The only output produced is the file **list.out** in **OUTPUT**. It contains the position in the file of the series that have produced abnormally large forecast errors ( according to the values of K1 and K2 selected), as well as the associated t- statistics.

# 3. INPUT PARAMETERS

## 3.1 AUTOMATIC PROCEDURE

**RSA** = 1 As RSA=3 below, but using always the default (" Airline ") model ( no automatic model identification ).

= 3 The program tests for the log/level specification, interpolates missing observations (if any), and performs automatic model identification and outlier detection and correction. Three types of outliers are considered: additive outliers, transitory changes and level shifts; the level of significance is set by the program and depends on the length of the series. The full model is estimated by exact maximum likelihood, and forecasts of the series up to a two-year horizon are computed. The model is decomposed and optimal estimators and forecasts of the components are obtained, as well as their mean squared error. These components are the trend-cycle, seasonal, irregular and (perhaps) transitory component. If the model does not accept an admissible decomposition, it is replaced by a decomposable one.

= 4 As before, but a pretest is made for the presence of Trading Day and Easter effects, with the first effect using a one parameter specification (working / non-working days).

= 5 As RSA=4, but a pretest for the presence of Leap Year effect is added.

= 6 As RSA=4, but the Trading Day specification uses 6 parameters (each working day, plus weekend).

= 8 As RSA=6, but the leap year effect is added.

## 3.2 TRAMO PARAMETERS

### 3.2.1 ARIMA model

**P** = 0 (Default) order of regular autoregressive polynomial.
= 1, 2, 3

**Q** = 1 (Default) order of regular moving average polynomial.
= 0, 2, 3

**D** = 1 (Default) order of regular differences.
= 0, 2

**BP** = 0 (Default) order# of seasonal autoregressive polynomial.
= 1

**BQ** = 1 (Default) order of seasonal moving average polynomial.
= 0

**BD** = 1 (Default) order of seasonal differences.
= 0

| | | |
|---|---|---|
| **INIT** | = 0 | (Default) All ARIMA parameters will be estimated. |
| | = 1 | Some parameters are fixed.The location of fixed parameters is entered setting : JQR(I)=1 ; JQS(I)=1 ; JPR(I)=1 ; JPS(I)=1 ; The fixed values of the parameters are entered as TH(i)=fixedvalue, PHI(i)=fixedvalue,.. |
| | = 2 | Values for all parameter input and no parameter estimation is done. Parameters entered in TH, BTH, PHI, BPHI. |
| **PHI** | = | Estimates of regular autoregressive parameters (Default: All -.1). Not input if INIT=0. If ( INIT=2 ) or ( INIT=1, JPR(I)=1 ), PHI(I)=k fixes the I-th regular AR parameter. |
| **TH** | = | Estimates of regular moving average parameters (Default: All -.1). Not input if INIT=0. If ( INIT=2 ) or ( INIT=1, JQR(I)=1 ), TH(I)=k fixes the I-th regular MA parameter. |
| **BPHI** | = | Estimates of seasonal autoregressive parameters (Default: All -.1). Not input if INIT=0. If ( INIT=2 ) or ( INIT=1, JPS(I)=1 ), BPHI(I)=k fixes the seasonal AR parameter. |
| **BTH** | = | Estimates of seasonal moving average parameters (Default All -.1). Not input if INIT=0. If ( INIT=2 ) or ( INIT=1,JQS(I)=1 ), BTH(I)=k fixes the seasonal MA parameter. |
| **JPR(I)** | = 1 | When INIT=1 parameter number I in the regular autoregressive polynomial fixed to the value set in PHI(I) (it is not estimated). |
| | = 0 | (Default) Parameter not fixed. |
| **JQR(I)** | = 1 | When INIT=1 parameter number I in the regular moving average polynomial fixed to the value set in TH(I) (it is not estimated). |
| | = 0 | (Default) Parameter not fixed. |
| **JPS(I)** | = 1 | When INIT=1 parameter number I in the seasonal autoregressive polynomial fixed to the value set in BPHI(I) (it is not estimated). |
| | = 0 | (Default) Parameter not fixed. |
| **JQS(I)** | = 1 | When INIT=1 parameter number I in the seasonal moving average polynomial fixed to the value set in BTH(I) (it is not estimated). |
| | = 0 | (Default) Parameter not fixed |
| **IMEAN** | = 0 | No mean correction. |
| | = 1 | (Default) Mean correction. |
| **LAM** | = 0 | Takes logs of data. |
| | = 1 | (Default) No transformation of data. |
| | = -1 | The program tests for the log-level specification. |
| **FCT** | = 1 | ( Default ) Real value. Controls the bias in the log/level pretest. |
| | > 1 | Favors levels; |
| | < 1 | Favors logs. |
| **TYPE** | = 0 | (Default) Exact Maximum Likelihood (for SEATS and TRAMO). |
| | = 1 | Least Squares (conditional for SEATS, unconditional for TRAMO). |

**UNITS** = 0 (Default) The units of the original series are preserved.
= 1 If the series units are too small ( min $z_t \geq 10^4$ ) or too large (max $z_t \leq 10^{-3}$ ), the series is rescaled.

### 3.2.2 Calendar Effects

**IEAST** = 0 (Default) No Easter effect.
= 1 Easter effect adjustment.
=-1 The program pretests for Easter effect.

**ITRAD** = 0 (Default) No Trading Day effect is estimated.
= 1 # of (M, T, W, Th, F) - # (Sat, Sun) x 5/2.One parameter specification.
= 2 As the previous case, but with leap-year effect correction.
= 6 # M - # Sun, # T - # Sun, ......, # Sat - # Sun. Six parameter specification.
= 7 As the previous case, but with leap-year correction.( Seven parameter specification .)
= -1 As ITRAD =1, but a pretest is made.
= -2 As ITRAD =2, but a pretest is made.
= -6 As ITRAD =6, but a pretest is made.
= -7 As ITRAD =7, but a pretest is made.

**IDUR** = 6 (Default) Duration of period affected by Easter (# of days).
= k a positive integer.

### 3.2.3 Outliers

**IATIP** = 0 (Default) No correction for outliers.
= 1 Automatic detection and correction for outliers.

**AIO** = 1 All outliers are treated as additive outliers or transitory changes (in this way the level of the series is preserved).
= 2 (Default) Additive outliers, transitory changes and level shifts are considered.
= 3 Only level shifts and additive outliers are considered.

Two integer parameters, INT1 and INT2, can be used to define the interval (INT1, INT2) over which outliers have to be searched. By default

INT1 = 1; INT2 = NZ ( number of observations in series )

When INT2 = -k < 0, outliers are automatically detected and corrected in the interval (INT1, NZ-k). Then, the detection procedure is applied to the last k observations, and if some outlier is detected a warning is printed, but no correction is made.

**IMVX** = 0 (Default) The fast method of Hannan-Rissanen is used for parameter estimation in the intermediate steps of the automatic detection and correction of outliers.
= 1 Maximum likelihood estimation is used.

**VA** = k A positive real number. Sets the critical value for outlier detection. The default value depends on NZ:

if (NZ <= 50) then VA = 3.0
if (50< NZ < 450) then VA = 3.0+0.0025*(NZ-50)
else VA = 4.0

**INT1, INT2** See parameter : AIO.

### 3.2.4 Automatic Model Identification

**INIC** = 0 (Default) No automatic model identification is performed for stationary model;
= 3 The program searches for regular polynomials up to order 3, and for seasonal polynomials up to order 1 ( stationary model );

**IDIF** = 0 (Default) No automatic model identification for non-stationary roots.
= 3 The program searches first for regular differences up to order 2 and for seasonal differences up to order 1.

**TSIG** = 1 (Default) Minimum t for significant mean.
= k a real number 0 < k < 2.

### 3.2.5 Other parameters

**INTERP** = 0 No interpolation of missing observations.
= 1 Interpolation of missing observations with the fixed-point smoother.
= 2 (Default) Interpolation of missing observations is made through regression ("Additive Outlier Approach").

When automatic model identification is simultaneously performed, missing values are interpolated using the additive outlier approach.

**NBACK** = 0 (Default) No out-of-sample forecast test.
= k<0 K a negative integer, then |k| observations are omitted from the end of the series. The model is estimated for the shorter series, one-period-ahead forecast errors are sequentially computed for the last k periods (without reestimation of the model), and an F-test is performed that compares the out-of-sample forecasts errors with the in-sample residuals.

**NPRED** = k a positive integer, # of multistep forecasts to compute when only TRAMO is used; When used with SEATS, NPRED is automatically set to MAX(2MQ,8), where MQ is the number of observations per year.
= 0 (Default).

### 3.2.6 Regression Variables

**IREG** = 0 (Default) No regression variable.
= k A positive integer.
k = # of regression variables entered by the user (regvariables with IUSER = 1) + NSER for the (NSER) variables entered as a matrix ( with NSER columns )in an external file (regvariables with IUSER = -1) + # of "a priori" specified outliers ( NSER in regvariables with IUSER = 2) + # intervention variables built by the program ( regvariables with IUSER = 0, ISEQ > 0 ).

**ILONG** Length of regression variable.
= NZ + MAX(2MQ, 8) if SEATS will be used after TRAMO.
= NZ + NPRED if only TRAMO is used.

**IUSER** = 1 The user will enter a series X(I), I=1 .. ILONG for this regression variable.
=-1 The program will read NSER series from a file. There must be NSER columns of lenght ILONG in this file separated by blanks, containing the NSER series.

| | | |
|---|---|---|
| | = 0 | (Default) No regression variable when ISEQ=0. When ISEQ>0 the program will generate the regression variable. |
| | = 2 | The user specifies the presence of some outliers; he / she will provide a sequence of NSER pairs of number-string: (t1, j1)..( tNSER, jNSER), where t denotes the position of the outlier and j denotes the type of outlier according to the following code: |

| | | |
|---|---|---|
| j = | IO | Innovation Outlier |
| = | AO | Additive Outlier |
| = | LS | Level Shift |
| = | TC | Temporary Change |

| | | |
|---|---|---|
| | = -2 | The program will read the holidays series X(I), I=1..ILONG from a file. The holidays are incorporated to the Trading Day variable. |
| **REGEFF** | = 0 | (Default) The regression effect is a separate additional component; it is not included in the seasonally adjusted series. |
| | = 1 | Regression effect assigned to trend. |
| | = 2 | Regression effect assigned to seasonal component. |
| | = 3 | Regression effect assigned to irregular component. |
| | = 4 | Regression effect assigned to the seasonally adjusted series, but as an additional separate component. |
| | = 5 | Regression effect assigned to transitory component. |
| | = 6 | Regression effect assigned to seasonal component as part of the calendar effect. |
| **ISEQ** | = k | (k a positive integer) only when IUSER=0. The program will generate one intervention variable of length ILONG consisting of k-sequences of ones separated by zeroes. The user will provide k-pairs of numbers; the j-th pair indicates the time index where the j-th sequence of ones is to begin and its length, respectively. |
| | = 0 | (Default) The program will generate no regression variable. |
| **DELTA** | = d | ($0 \leq d \leq 1$); the filter 1/(1-dB) will be applied to the k sequences of ones generated by the program. |
| | = 0 | (Default). |
| **DELTAS** | = $d_S$ | ($0 \leq d_S \leq 1$); the filter $1/(1-d_sB^s)$, s=MQ, will be applied to the k sequences of ones generated by the program. |
| | = 0 | (Default). |
| **ID1DS** | = 1 | The program will apply the filter $1/(1-B)(1-B^s)$, s=MQ, to the k sequences of ones generated by the program. |
| | = 0 | (Default). |

### 3.3 SEATS PARAMETERS

| | | |
|---|---|---|
| **XL** | = .99 | (Default) When the modulus of an estimated root falls in the range (XL,1), it is set equal to 1 if root is in AR polynomial. If root is in MA polynomial, it is set equal to XL. |
| | = k | A real number, $.5 < k < 1$. |

**EPSPHI** = 3 (Default).

= k A real number. When the AR polynomial $\phi(B)$ contains a complex root, this root is allocated to the seasonal if its frequency differs from one of the seasonal frequencies by less than EPSPHI (measured in degrees). Otherwise, it goes to the transitory component.

**RMOD** = .5 (Default)

= k (0 < real number < 1) Cutting point for the modulus of an AR real root. If modulus <k it goes to the transitory component ; if >k, to the trend-cycle.

**NOADMISS** = 0 (Default) When model does not accept an admissible decomposition,no approximation is made.

= 1 When model does not accept an admissible decomposition, it is automatically replaced with a decomposable one.

**IQM** = k Number of autocorrelations used in computing Ljung-Box Q-statistics.The default value depends on MQ. For MQ=12 it is equal to 24; for MQ=2, 3, 4, 6 it is equal to 4MQ; for MQ=1 it is equal to 8.

## 3.4 TERROR PARAMETERS

**SENS** = 0 Low sensitivity

= 1 Medium sensitivity ( Default )

= 2 High sensitivity

The parameter SENS sets two parameters, $k_1$ and $k_2$. Let t = out-of-sample forecast error/standard deviation of in-sample residuals.Then, for a particular series,

If $|t| > k_2$, the new observation in the series is classified as "likely" to contain an error.

If $k_1 < |t| \leq k_2$, the new observation is classified as containing a "possible" error.

If $|t| \leq k_1$, the new observation is accepted as without error.

The values of $k_1$ and $k_2$ for the different levels of sensitivity are as follows:

| | | |
|---|---|---|
| SENS = 0 | $k_1 = 5$ | $k_2 = 6$ |
| SENS = 1 | $k_1 = 4$ | $k_2 = 5$ |
| SENS = 2 | $k_1 = 3$ | $k_2 = 4$ |

These values can be changed by setting

SENS ≥ 3,

one can then enter the new values of $k_1$ and/or $k_2$.

**NMATRIX** = 1 ( Default ) The matrices that summarize the results, described in 2.5.4 c), are computed.

= 0 The matrices in **Out-Matrix** are not computed.

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