BV4.1 – Methodology and User-friendly Software for Decomposing Economic Time Series

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**Abstract**

In Germany the decomposition and the seasonal adjustment of economic time series with the BV procedure have a long tradition. In the late sixties the mathematical bases were developed at the Technical University Berlin and the German Institute for Economic Research (DIW). Shortly after (1972) the Federal Statistical Office (DESTATIS) established a first practicable version of the procedure to provide the general public with information on major business-cycle indicators. Since 1983 BV has been used, a further development by DESTATIS. BV turned out to be very suitable for German official statistics.

In the course of 2004, BV was replaced by the new version BV4.1 with methodological improvements concerning the estimation of outliers and calendar effects. In addition, the user himself can now specify explanatory variables, which are to be considered with the analysis.

The first part of the BV4.1 procedure is the identification of (potential) additive outliers. It is based initially on the assumption that within sufficiently short moving time intervals with fixed length $M$ - the so-called basic spans - the time series is the realisation of a normal stationary process. If the difference between an observation and the determined (conditional) expected value is more than a certain fixed multiple $\tau$ (sigma limit) of its standard deviation, then the observation is regarded as an outlier.

In the second part of the procedure the integrated estimation of outliers, calendar effects and of the effects of series specific user-defined variables is accomplished. Based on the general additive model for time series decomposition

$$O = T + S + C + U^* + E + R,$$

“filtered” by the linear BV4.1 filter procedure $F$ for trend-cycle and seasonal adjustment, this is done using the following linear regression model

$$F(O) = F \left( \sum_{i=1}^{h} \mu_i T_i \right) + F \left( \sum_{i=1}^{k} \nu_i S_i \right) + \sum_{i=1}^{l} \alpha_i F(C_i) + \sum_{i=1}^{m} \beta_i F(U_i^*) + \sum_{i=1}^{n} \gamma_i F(E_i) + \varepsilon$$

($T_i = $ trend-cycle regressors, $S_i = $ seasonal regressors, $C_i = $ calendar regressors, $U_i^* = $ series specific user-defined regressors, $E_i = $ series specific outlier dummy regressors according to the outliers identified at step 1, $\varepsilon = $ error term, $R = $ residual component). Because
the model used for the estimation of the model parameters \( \alpha_i, \beta_i, \gamma_i \) (i.e. the components \( C, U^+ \) and \( E \)) is

\[
F(O) = \sum_{i=1}^{j} \alpha_i F(C_i) + \sum_{i=1}^{m} \beta_i F(U_i^+) + \sum_{i=1}^{n} \gamma_i F(E_i) + \varepsilon^*.
\]

The method of estimating the parameters is that of ordinary least squares.

In the last part the procedure proceeds with the estimation of the trend-cycle and the seasonal component of series \( O \), based on the time series adjusted for outliers, calendar effects and the effects of the user-defined variables \( O' = O - \hat{C} - \hat{U}^+ - \hat{E} = T + S + R^* \). This is done using fixed linear filters (fixed filter approach) derived from different component-specific local (moving) regression models, where locally the trend-cycle and the seasonal component are approximated by polynomials and trigonometric functions. The model parameters are estimated by the method of weighted least squares.

Due to the local (quasi-dynamic) modelling approach BV4.1 is very efficient in modelling changing seasonal time series structures. The trend-cycles are depicted plausibly in terms of economic points of view. Because BV4.1 is a fixed-filter approach on principal the results do not depend on the respective user. Due to the linear filters used by the BV4.1 procedure the components of partial series add up to the corresponding component of the aggregate series (i.e. there is no difference between indirect and direct analysis). Another feature of BV4.1 is the low cost-benefit ratio. To produce high-quality results, the user of BV4.1 requires neither a special training or even expert knowledge nor long-term experiences in dealing with the procedure.

In February 2006 a new version of the corresponding software BV4.1 was published. System requirements of the software: Windows PC (from Windows 4.0/ Windows 98). The software supports the file formats EXCEL, ACCESS, CSV and SQL Server. With BV4.1 the user can analyse monthly and quarterly time series. The analysis runs are controlled by a user-friendly graphical user interface. The software offers, too, the possibility of mass production of time series decompositions. Furthermore there is the possibility of so-called successive analyses (i.e. analyses where the analysis spans are extended gradually by one additional months or quarters, respectively). This option is useful for examining such revisions of analysis results originating from the BV4.1 procedure itself. The user has various possibilities of graphic evaluations of the results. The output of BV4.1 analyses contains detailed information for each executed time series analysis e.g. on identified outliers, estimates of the model parameters and the results of the time series decomposition and the seasonally adjusted series. For some components (e.g. original series, trend-cycle, seasonally adjusted series) the percentage of change is calculated. The user can generate output files for the processing of the results: series specific files where all components and the most important adjusted series are stored, series specific files with a reduced number of components and adjusted series and some component specific if more than one series was analysed.