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

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Introduction

In German official statistics the decomposing and the seasonal adjustment of economic time series with the BV procedure has a long history.

The Federal Statistical Office (DESTATIS) has used the procedure since 1972. Since 1983 DESTATIS has used the version BV4, which turned out to be very suitable.

In the course of 2004, BV4 was replaced by the new version BV4.1 with improved approaches for the estimation of outliers and calendar effects.
The BV4.1 Procedure

Methodological Overview:
- Additive model for time series decomposition

\[ O = T + S + C + U + E + R \]

- \( O \): original time series
- \( T \): trend-cycle component
- \( S \): seasonal component
- \( C \): calendar component
- \( U \): user-defined component
- \( E \): outlier component
- \( R \): irregular component
The BV4.1 Procedure

Methodological Overview:

- Integrated estimation of outliers, calendar effects and of the effects of series specific user-defined variables:
  - Linear regression model

\[ O = \sum_{i=1}^{h} \mu_i T_i + \sum_{i=1}^{k} \nu_i S_i + \sum_{i=1}^{l} \alpha_i C_i + \sum_{i=1}^{m} \beta_i U_i + \sum_{i=1}^{n} \gamma_i E_i + \epsilon \]

- \( T_i \) = trend-cycle regressors,
- \( U_i \) = series specific user-defined regressors,
- \( S_i \) = seasonal regressors,
- \( E_i \) = series specific outlier dummy regressors,
- \( C_i \) = calendar regressors,
- \( \epsilon \) = error term

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Methodological Overview:

- Outlier identification (setting of the $E_i$'s):
  - Assumption: within sufficiently short moving time intervals of fixed length (basic spans) the time series is the realisation of a normal stationary process.
  - Determination of the conditional distributions of the observations of the time series directly left and/or right outside the basic spans (backward and forward identification of outliers)
  - Observation is regarded as an outlier, if the difference between the observations and the conditional expected value exceeds a certain user-defined multiple of its (conditional) standard deviation
Methodological Overview:

- Integrated estimation of outliers, calendar effects and of the effects of series specific user-defined variables:
- Linear regression model “filtered” by the linear BV4.1 filter \( F \) for trend-cycle and seasonal adjustment:

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

where \( \varepsilon^* = F(\varepsilon) \) indicates the new error term
The BV4.1 Procedure

Methodological Overview:

- Integrated estimation of outliers, calendar effects and of the effects of series specific user-defined variables:
  - Model for estimating the parameters $\alpha_i$, $\beta_i$, $\gamma_i$ and thus the components $C$, $U$ and $E$:

$$F(O) = \sum_{i=1}^{l} \alpha_i F(C_i) + \sum_{i=1}^{m} \beta_i F(U_i) + \sum_{i=1}^{n} \gamma_i F(E_i) + \varepsilon$$

- Because $F\left(\sum_{i=1}^{h} \mu_i T_i\right) \approx 0$ and $F\left(\sum_{i=1}^{k} v_i S_i\right) \approx 0$

- Estimation by the method of ordinary least squares
The BV4.1 Procedure

Methodological Overview:

- Estimation of the trend - cycle and seasonal components:
  - Based on the time series adjusted for outliers, calendar effects and the effects of the user-defined variables:

\[ O^* = O - \hat{C} - \hat{U} - \hat{E} = T + S + R \]
The BV4.1 Procedure

Methodological Overview:
- Estimation of the trend-cycle and the seasonal components:
  - Fixed-filter approach, i.e., fixed linear filters derived from different component specific local (moving) regression models
  - Locally approximation by polynomials and trigonometric functions
  - Estimation of $T$ and $S$ by the method of weighted least squares

Note: Linear Filter $F = (I-F2) (I-F1)$ for trend-cycle and seasonal adjustment where:
- $F1 = \text{linear filter for estimating } T$
- $F2 = \text{linear filter for estimating } S$
More detailed information on the methodology:

http://www.destatis.de/download/mv/MethodenberichtBV4_e.pdf
The BV4.1 Procedure

Features of BV4.1:

- Efficient modelling of changing seasonal time series structures. (LINK SA, LINK S)
- Trend-cycles are depicted plausibly in terms of economic points of view. (LINK TC)
- Low cost-benefit ratio. To produce high-quality results, the user of BV4.1 requires neither a special training nor long-term experience in dealing with the procedure.
The BV4.1 Procedure

Features of BV4.1:

- BV4.1 is a fixed-filter approach. So on principle the results do not depend on the respective user.
- Due to the linear filters used by the BV4.1 procedure, there is on principle no difference between indirect and direct analysis of aggregate series (i.e., the BV4.1 components of partial series add up to the corresponding component of the aggregate series).
- Possibility to integrate so-called user-defined explanatory variables into the time-series model.
The BV4.1 procedure

Features of BV4.1:

- For decomposing or seasonally adjust time series by the BV4.1 procedure there is available a user-friendly software.
The BV4.1 Software

Technical requirements:

- PC for Windows NT 4.0/Windows 98+.
- Support of the file formats CSV, EXCEL 95+, ACCESS 97+ and SQL-Server.
The BV4.1 Software

Capabilities and program limits:

- BV4.1 analyses of monthly and quarterly time series.
  - Lengths $L$ of the series (number of time series observations):
    - $59 < L < 361$ for monthly time series,
    - $16 < L < 361$ for quarterly time series.
- BV4.1 analyses with up to 15 user-defined explanatory variables.
The BV4.1 Software

Capabilities and program limits:

- Controlling of the BV4.1 analyses by a user-friendly graphical user interface (GUI).
- Possibility of mass production of BV4.1 analyses.
- Possibility to execute so-called successive analyses (i.e. analyses where the analysis spans are extended gradually by one additional month and quarter, respectively).
- Various possibilities of graphical evaluations of the results.
The BV4.1 Software

Capabilities and program limits:

- Output with detailed information on each executed time series analysis, e.g. on
  - identified outliers,
  - estimates of model parameters,
  - the results of the time series decomposition and the seasonally adjusted series.
The BV4.1 Software

Capabilities and program limits:

- Calculation of the percentage of change for some components, e.g.
  - original series
  - trend - cycle
  - seasonally adjusted series
The BV4.1 Software

Capabilities and program limits:

- 3 different options for producing output files intended for the processing of the results of the analyses.
  - “Integrated, complete”: production of series specific output files where all components and the most important adjusted series are stored.
  - “Integrated, reduced”: production of series specific output files with a reduced number of components and adjusted series.
  - “Separated (reduced)”: production of component specific output files with the original series, the trend-cycle components, the seasonally adjusted series and the calendar adjusted series of the respective program run.
Remark:

BV4.1 is a freeware.

You can download it from:
http://www.destatis.de/download/mv/spbv41produktb_e.pdf

Thank you for your attention!

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