ESTP: Introduction to seasonal adjustment

Series Decomposition with SEATS

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Objectives of this sequence

- understand the decomposition philosophy in SEATS algorithm
- be able to read JD+ GUI output on SEATS
- customize the parameters if automatic results unsatisfactory

Decomposition phase : introductory remarks

- We present the two most popular methods : X11 and SEATS
- They are available in JDemetra+ graphical user interface (GUI) and via R interface
- JDemetra+ is a set of algorithms and offers more possibilities (STL, STS,...) but only via R packages (until now)
- for in-depth explanation, we focus more on X11 : the maths is less hard, allows to get a good grasp of filtering principles

A few words about TRAMO(-SEATS)

- TRAMO = Time series regression with ARIMA noise, Missing values and Outliers
- TRAMO is the pre-adjustment step preceding SEATS, just like the Reg-Arima precedes X-11
- Reg-Arima and TRAMO algorithms are very close (steps and results)

Their common objectives are :

- correct the raw series for deterministic effects (outliers, calendar)
- forecast the series

(see sequence on Pre-Treatment)

Basic idea of SEATS

SEATS = Signal Extraction in ARIMA Time series

SEATS uses the ARIMA model of the linearized series, the procedure is built on spectrum decomposition

$$\underbrace{\Phi(B)\Phi_s(B)(I-B)^d(I-B^s)^D}_{\Phi(B)} X_t = \underbrace{\Theta(B)\Theta_s(B)}_{\Theta(B)} \varepsilon_t$$

Hypotheses :

1. the linearized series can be modelled with an ARIMA model
2. the components are orthogonal ; the causes of seasonal fluctuations are thought to be independent from the causes of long-term evolution
3. an ARIMA model can be assigned to each component (S, T, I) (a transitory component can be added for technical reasons to cope with low order correlations which do not belong to trend or seasonal)

Components (1/2)

- Trend : represents the long-term evolution and displays a peak at frequency $\omega = 0$
- Seasonal : captures periodic fluctuations and displays peaks at seasonal frequencies 0
- Irregular : captures the movements that don't belong to the trend or seasonal

Components (2/2)

The Irregular component is usually a white noise, but in some cases it also contains a Transitory component :

- optional
- captures short lived, fairly erratic behavior that is not white noise.

The rationale for its use is :

- the variation it contains should not contaminate the trend or seasonal components. Its removal allows to obtain smoother and more stable S and T
- from testing and diagnostics point of view it is suitable to preserve a purely white noise irregular, computed as a residual

Decomposition

X_t can be rewritten as :

$$X_t = \frac{\Theta(B)}{\Phi(B)}\varepsilon_t = \underbrace{\frac{\theta_T(B)}{\phi_T(B)}\varepsilon_{T,t}}_{\text{trend}} + \underbrace{\frac{\theta_S(B)}{\phi_S(B)}\varepsilon_{S,t}}_{\text{seasonal}} + \underbrace{\nu_t}_{\substack{\text{Irregular} \\ \text{(white} \\ \text{noise)}}}$$

An ARIMA model is assigned to each component.

Solutions are infinite : SEATS chooses the one which maximizes the variance of the irregular.

Estimation via Wiener-Kolmogorov Filter (based on auto-correlations and spectrum)

X-11 is widely used in France and Germany, whereas SEATS is preferred in Spain and Italy

TRAMO-SEATS can handle bimonthly series in JD+, which is not the case for X-13-ARIMA (should be harmonized in JDemetra+ version 3)

Quality check in SEATS

SEATS maximizes the variance of irregular component while the trend-cycle and seasonal component are as stable as possible

The variance diagnostic compares the variance of the stationary transformation of the components innovation with the variance of their theoretical estimators and the variance of their empirical (actually obtained) estimate

The theoretical variance (Estimator) should be similar to the estimate actually obtained (Estimate). Large differences between the theoretical and empirical values would indicate misspecification of the overall model

Pratical Decomposition with Seats

Unlike X-11 (filter length, irregular correction) : no “clear” user intervention is possible in SEATS

Seats can change the model selected by TRAMO if non decomposable : there is a flag in the ARIMA node.

If the decomposition is unsatisfactory (for example residual seasonality)

- act on the linearized series
- manually change the model selected by TRAMO (for example try out an airline model (0,1,1)(0,1,1))

Parameters in JD+

SEATS parameter options in JDemetra+

Parameter	Description	Options (*default*)
Prediction length	Forecast used in the decomposition	no. of periods (positive values) or years (negative values) (*-1*)
Approximation mode	Modification type for inadmissible models	None, *Legacy*, Noisy
MA unit root boundary	Modulus threshold for resetting MA "near-unit" roots	[0.9, 1] (*0.95*)
Trend boundary	Modulus threshold for assigning positive real AR roots	[0, 1] (*0.5*)
Seasonal tolerance	Degree threshold for assigning complex AR roots	[0, 10] (*2*)
Seasonal boundary	Modulus threshold for assigning negative real AR roots	[0, 1] (*0.8*)
Seas. boundary (unique)	Same modulus threshold unique seasonal AR roots	[0, 1] (*0.8*)
Method	Estimation algorithm for the unobserved components	*Burman*, KalmanSmoother, McElroyMatrix

Decomposition results (1)

In the GUI expand the "Decomposition" node :

- "stochastic series" displays the decomposition of the linearized series (names in the output : "decomposition.s_lin",. . ..)
- "components" displays the levels of the final (1) components (idem as the series displayed in "Main>Tables") (names in the output : "decomposition.s_cmp",. . ..)

(1) final = decomposition results (S T I) + pre-adjustment (outliers, calendar)

- "stochastic series" and "components" display the same results if : additive model + no pre-adjustment effect

Additional ressources on Seats

- Handbook on seasonal adjustment (Eurostat)
  https://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/KS-GQ-18-001

the output and parameter customization in JDemetra+

- Documentation JDemetra+ (includes theory description)
  https://jdemetradocumentation.github.io/JDemetra-documentation/