DEUTSCHE BUNDESBANK
EUROSYSTEM

Elementary seasonal adjustment of economic data with JDemetra+: Module IV – Quality assessment

Dr Karsten Webel / Deutsche Bundesbank, DG Statistics

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Aims

Theory

- Basic understanding $\rightsquigarrow$ Ideas, concepts
- Approach $\rightsquigarrow$ X-11
- Pretreatment $\rightsquigarrow$ RegARIMA models

Application

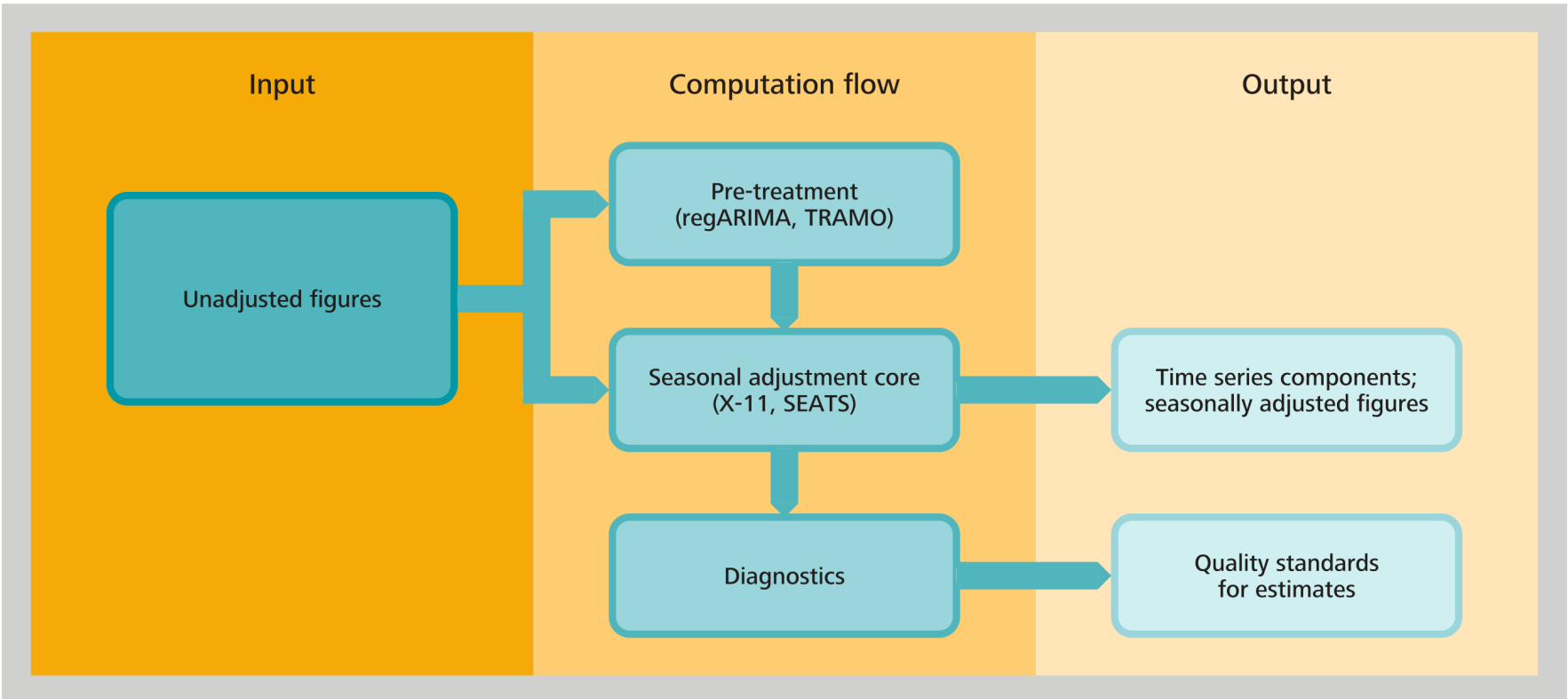
- Software $\rightsquigarrow$ JDemetra+ (JD+)
- Specification $\rightsquigarrow$ Options
- Results $\rightsquigarrow$ Interpretation, quality assessment

Discussion

- Your questions $\rightsquigarrow$ Practical problems

Road map

Structure of JDemetra+



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Overview

Questions

- Data $\rightsquigarrow$ Need for seasonal adjustment?
- SA data $\rightsquigarrow$ Quality of seasonal adjustment?

Answers

- Dependence measures $\rightsquigarrow$ Autocorrelations, periodogram
- Tests $\rightsquigarrow$ Seasonality
- Heuristics $\rightsquigarrow$ M- & Q-statistics

Dependence measures (I/III)
Autocorrelation function (ACF)

Data_{t-1} Data_{t} Data_{t+1} ... Data_{t+h-1} Data_{t+h} Data_{t+h+1}

Normalised time-constant linear dependence

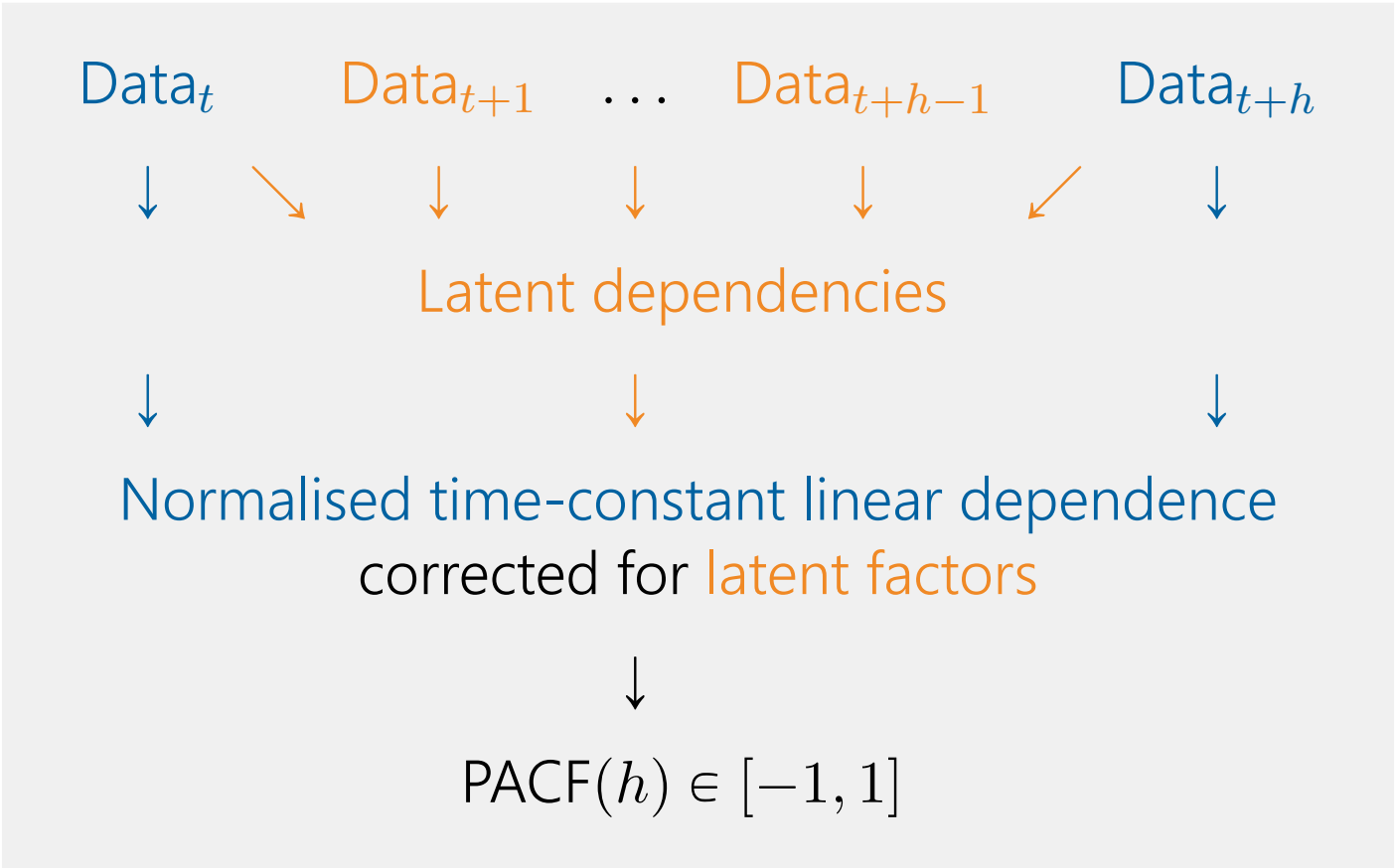
$\downarrow$

$\text{ACF}(h) \in [-1, 1]$

Assumption

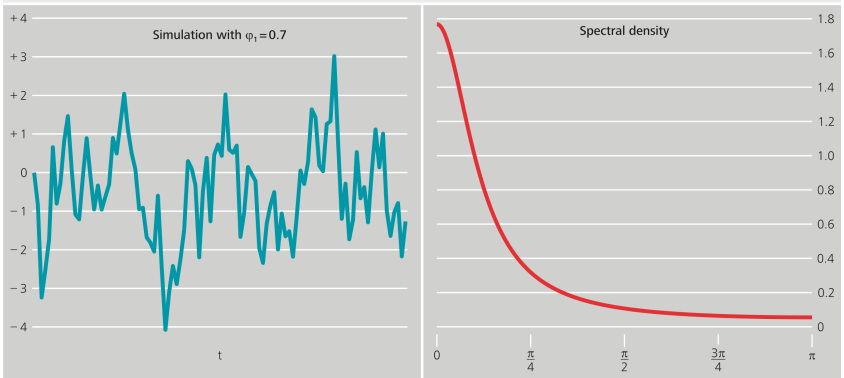
- Data $\rightsquigarrow$ Weakly stationary

Dependence measures (II/III)
Partial autocorrelation function (PACF)



Dependence measures (III/III)
Periodogram: AR (1) process, unit WN variance

Dominance of long cycles



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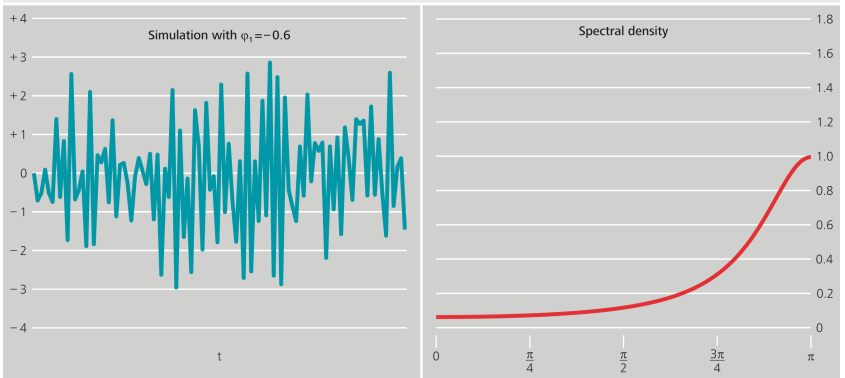
Dominance of short cycles



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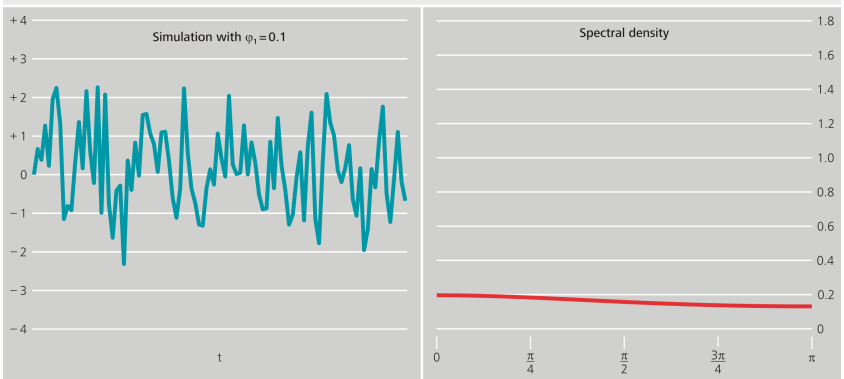
No dominance of any cycle



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Cycles per year	1	2	3	4	5	6
Duration in months	12	6	4	3	2.4	2
Seasonal frequency	$\frac{\pi}{6}$	$\frac{2\pi}{6}$	$\frac{3\pi}{6}$	$\frac{4\pi}{6}$	$\frac{5\pi}{6}$	π
Duration in quarters	4	2				
Seasonal frequency	$\frac{\pi}{2}$	π				

Seasonality tests in JD+ (I/VIII)
Overview

Name	Variable checked for significance	Short
Modified QS-test	Autocorrelations at seasonal lags	QS
Friedman-test	ANOVA with repeated measures on intra-year ranks	FT
Kruskal-Wallis-test	ANOVA without repeated measures on overall ranks	KW
Test for spectral peaks	Tukey and AR(30) spectra at seasonal frequencies	SP
Periodogram-test	Weighted sum of periodogram at seasonal frequencies	PD
F-test on seasonal dummies	Effects of seasonal dummies in the "$(pdq)(000)$ + mean + seasonal dummies" model*	SD

* Variant 1: $(pdq) = (011)$, variant 2: (pdq) according to automatic model identification.

Seasonality tests in JD+ (II/VIII)
Ljung-Box-test

$$LB_H = \sum_{h=1}^{H} w(h)\,\text{ACF}^2(h), \quad \text{with } w(h) = \frac{T(T+2)}{T-h}$$

Hypothesis

- Data $\rightsquigarrow$ Zero autocorrelations (i.e. independence)

Decision

- Rejection if LB_H too large

Seasonality tests in JD+ (III/VIII)
Modified QS-test

$$QS = \begin{cases} w(12)\,\text{ACF}^2(12) + w(24)\left[\max\{0, \text{ACF}(24)\}\right]^2, & \text{ACF}(12) > 0 \\ 0, & \text{ACF}(12) \leqslant 0 \end{cases}$$

Hypothesis

- Data $\rightsquigarrow$ No positive autocorrelation at seasonal lags (i.e. no stable seasonality)

Decision

- Rejection if QS too large

Seasonality tests in JD+ (IV/VIII)
Friedman-test

$$FT = \frac{\text{Variance of month-specific mean ranks}}{\text{Variance of ranks within months}}$$

Rank assignment

- Within each year $\rightsquigarrow 1 \leqslant \text{rank}_{ij} \leqslant \tau$

Hypothesis

- Data $\rightsquigarrow$ Same month-specific mean ranks (i.e. no stable seasonality)

Decision

- Rejection if FT-statistics too large

Seasonality tests in JD+ (V/VIII)
Kruskal-Wallis-test

$$KW = \frac{\text{Variance of month-specific mean ranks}}{\text{Variance of ranks within months}}$$

Rank assignment

- Within observation period $\rightsquigarrow 1 \leqslant \text{rank}_{ij} \leqslant T$

Hypothesis

- Data $\rightsquigarrow$ Same month-specific mean ranks (i.e. no stable seasonality)

Decision

- Rejection if KW-statistics too large

Seasonality tests in JD+ (VI/VIII)
Test for spectral peaks

Idea

- Spectral peaks $\rightsquigarrow$ Visual significance
- Tukey & AR(30) spectra $\rightsquigarrow$ Combination

Hypothesis

- Data $\rightsquigarrow$ No visually significant seasonal peaks (i.e. no seasonality)

Decision

- Rejection if too many visually significant seasonal peaks
- Consideration $\rightsquigarrow$ Location of seasonal peaks

Seasonality tests in JD+ (VII/VIII)
Periodogram-test

$$PD = \text{Rescaled}\left[2\sum_{j=1}^{5} I(\text{SF}_j) + I(\text{SF}_6) \times \begin{Bmatrix} 1, & T \text{ even} \\ 0, & T \text{ odd} \end{Bmatrix}\right]$$

Hypothesis

- Data $\rightsquigarrow$ No seasonal peaks (i.e. no seasonality)

Decision

- Rejection if PD-statistics too large

Seasonality tests in JD+ (VIII/VIII)

F-test on seasonal dummies

$$SD = \text{Rescaled } \left(\hat{\boldsymbol{\beta}}^{\top} \hat{\boldsymbol{\Sigma}}_{\hat{\boldsymbol{\beta}}}^{-1} \hat{\boldsymbol{\beta}} \right) \text{ from model}$$

$$\phi_p(B)(1-B)^d \left(\text{Data}_t - \hat{\boldsymbol{\beta}}^{\top} \textbf{Dummies}_t \right) = \mu + \theta_q(B)\, \varepsilon_t$$

Hypothesis

- Data $\rightsquigarrow$ Zero effects for seasonal dummies (i.e. no stable seasonality)

Decision

- Rejection if SD-statistics too large

Additional F-tests (I/II)
Stable seasonality

$$F_S = \frac{\text{Variance of month-specific mean SI ratios}}{\text{Variance of SI ratios within months}}$$

Hypothesis

- Seasonal factors $\rightsquigarrow$ Same month-specific averages (i.e. no stable seasonality)

Decision

- Rejection if F_S too large

Additional F-tests (II/II)
Moving seasonality

$$\left|(\widehat{si})_{ij} - 100\right| = \text{Year}_i + \text{Month}_j + \text{Residual}_{ij}$$

Hypothesis

- SI ratios $\rightsquigarrow$ Absence of annual effects (i.e. no moving seasonality, $\text{Year}_1 = \text{Year}_2 = \cdots = \text{Year}_T$)

Decision

- Rejection if F_M-statistic too large

Heuristics (I/III)

M-statistics: basic idea

Indication

- Seasonal adjustment $\rightsquigarrow$ Quality
- Development $\rightsquigarrow$ Statistics Canada

Construction

- Domain $\rightsquigarrow$ $[0, 3]$
- Acceptance region $\rightsquigarrow$ $[0, 1]$

Warning

- Relevance $\rightsquigarrow$ Limited

Heuristics (II/III)

M-statistics: $M7$

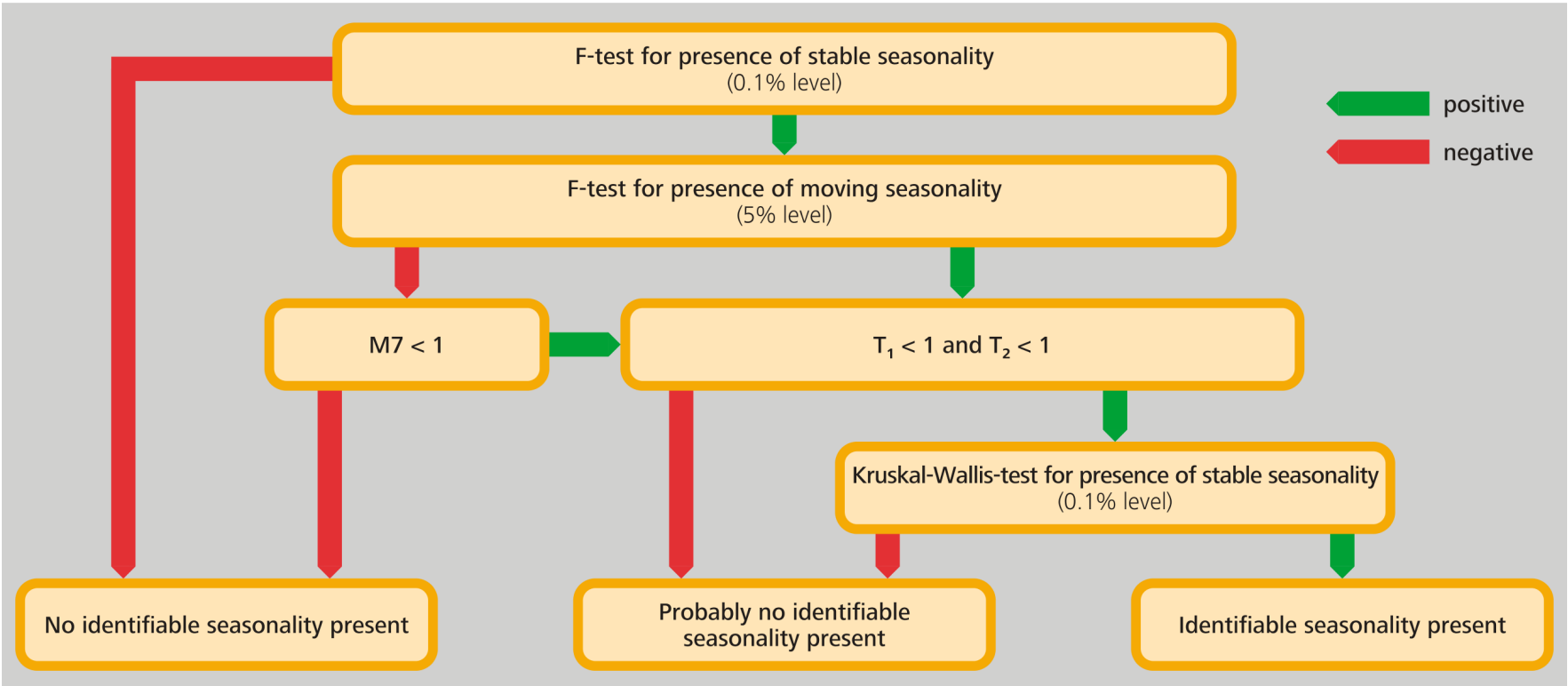
$$M7 = \sqrt{\frac{1}{2}(T_1 + T_2)}, \quad \text{with } T_1 = \min\left\{\frac{7}{F_S}, 9\right\}, T_2 = \min\left\{\frac{3F_M}{F_S}, 9\right\}$$

Interpretation

- "Ratio" $\rightsquigarrow$ Stable (F_S) & moving (evolutive) seasonality (F_M)

Heuristics (III/III)
Identifiable seasonality

Combined test for presence of identifiable seasonality



Source: Ladiray and Quenneville (2001).
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