DEUTSCHE BUNDESBANK
EUROSYSTEM

Elementary seasonal adjustment of economic data with JDemetra+: Module II – Pretreatment

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Aims

Theory

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

Application

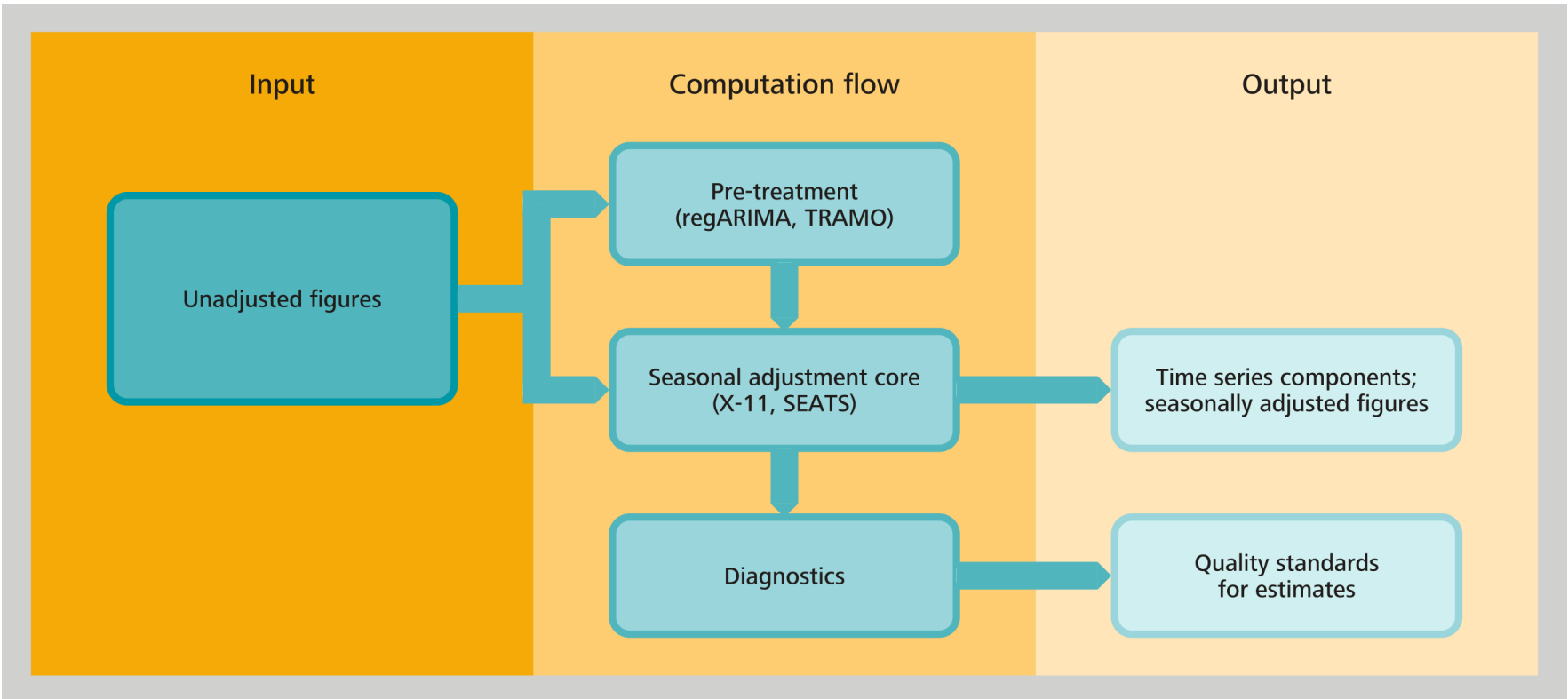
- Software $\rightsquigarrow$ JDemetra+ (JD+)
- Specification $\rightsquigarrow$ Options
- Results $\rightsquigarrow$ Interpretation, quality assessment

Discussion

- Your questions $\rightsquigarrow$ Practical problems

Road map

Structure of JDemetra+



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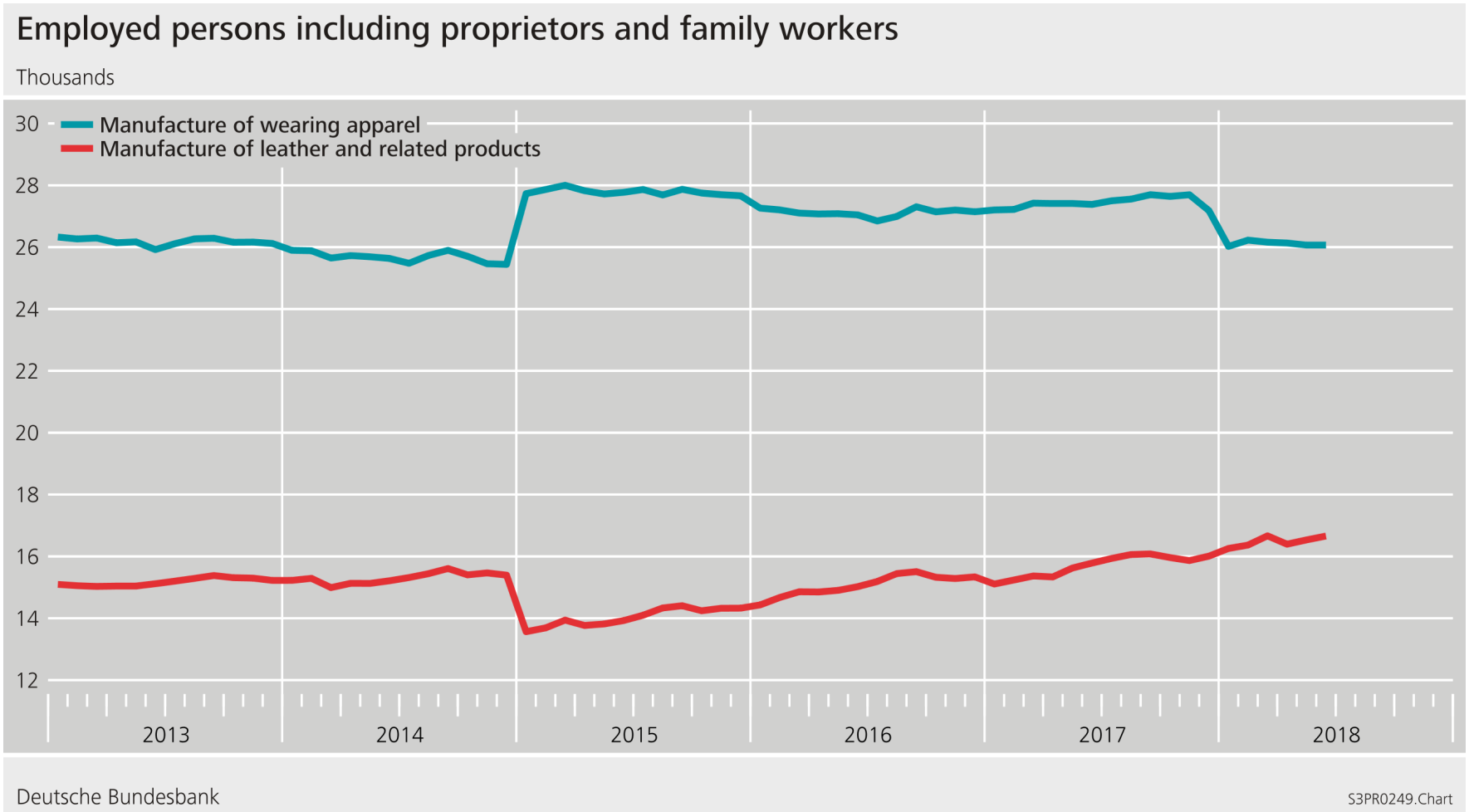
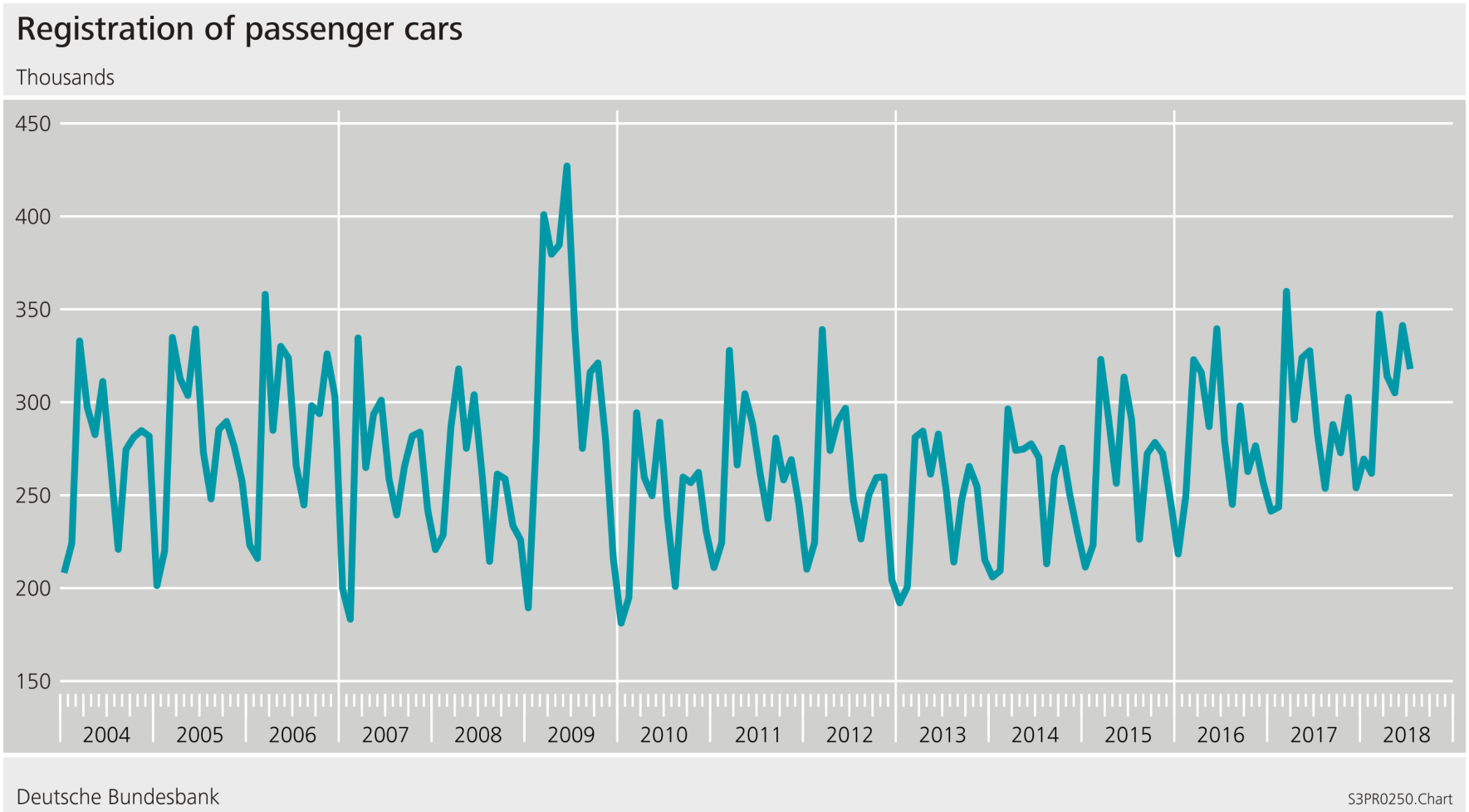
S3PR0018B.Chart

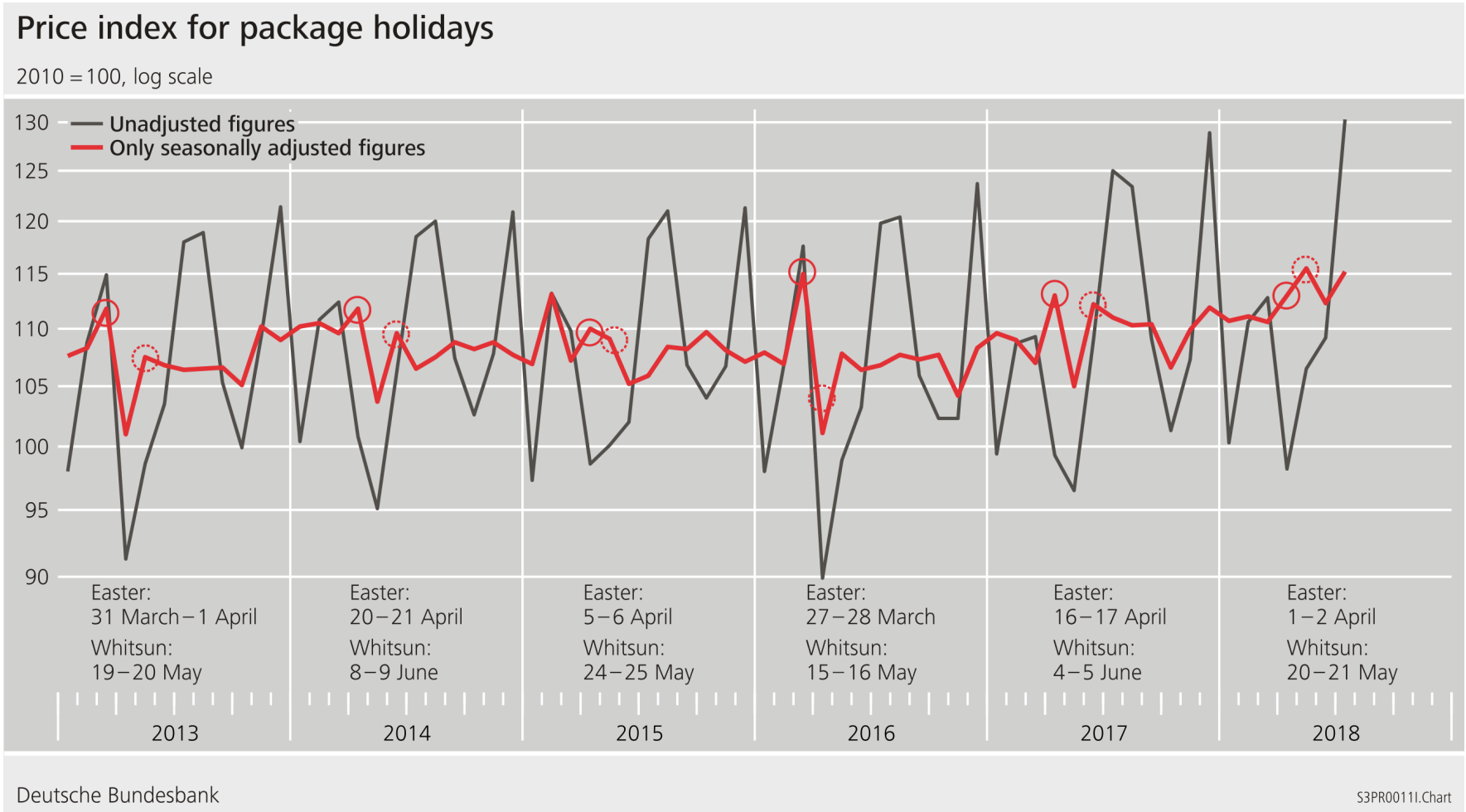
Messy data (I/III)
Persistent outliers: change in classification



Messy data (II/III)
Temporary outliers: monetary incentive



Messy data (III/III)
Calendar variation: moving holidays



Reasons (I/II)
Outliers

Persistent changes

- Classification
- Legislation
- Economic policy

Temporary unusual circumstances

- Atypical holiday constellations
- Major sport events
- Large-scale orders
- Strikes
- Extreme weather conditions

Reasons (II/II)
Calendar variation

Stock data

- Reporting $\rightsquigarrow$ Day of the week
- Currency in circulation, overnight deposits, etc.

Flow data

- Each weekday $\rightsquigarrow$ Varying number over months
- Orders received, output, turnover, etc.

Moving holidays

- Easter, Whitsun, etc.

Pretreatment regression model

Goals

- Outliers $\rightsquigarrow$ Temporary removal
- Calendar effects $\rightsquigarrow$ Permanent removal
- Data $\rightsquigarrow$ Log transformation, “optimal” forecasts

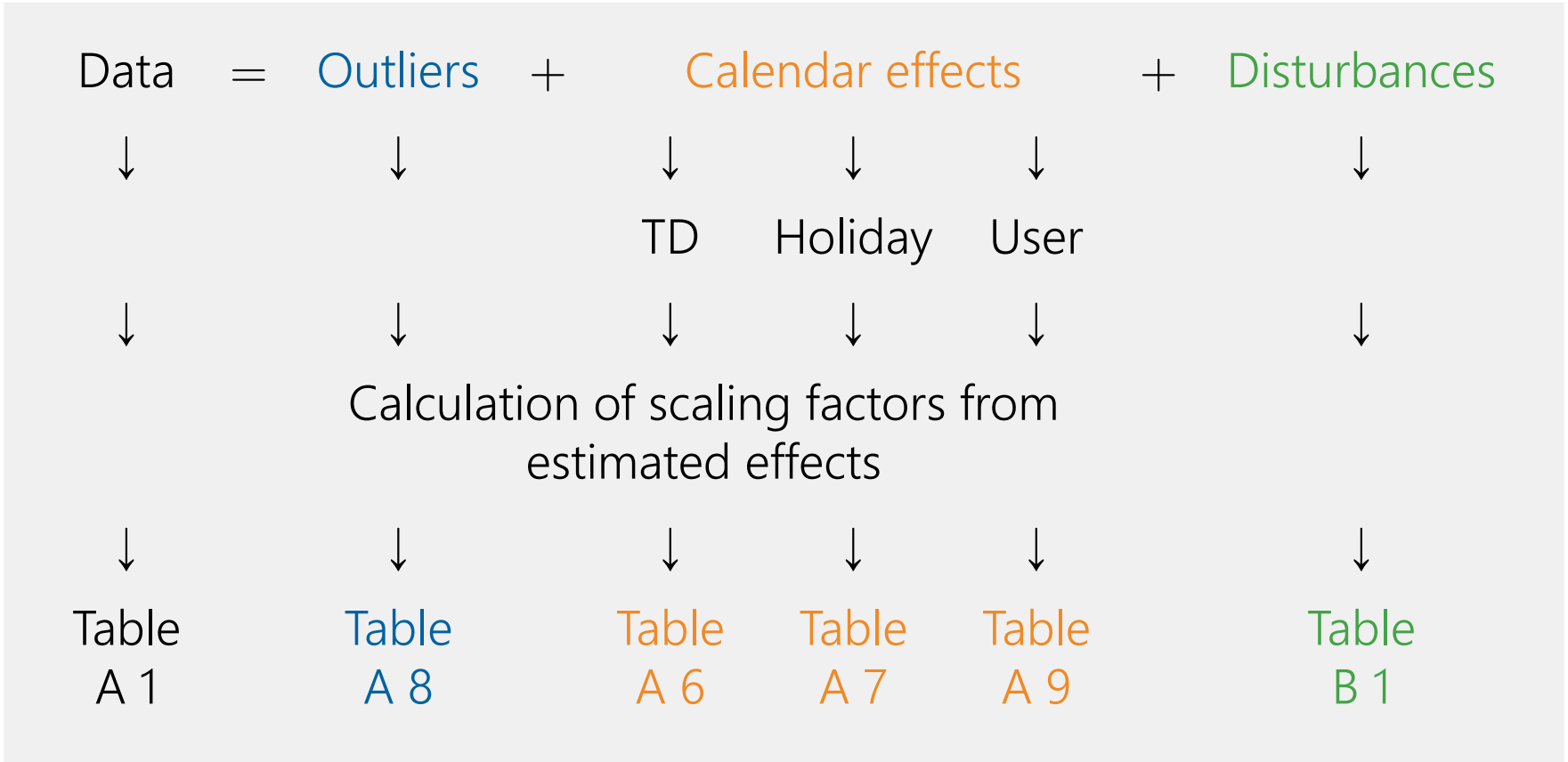
Regression equation

- Linear regression model $\rightsquigarrow$ Exogenous effects
- Independent variables $\rightsquigarrow$ Outlier & calendar regressors
- Disturbances $\rightsquigarrow$ ARIMA process

ARIMA equation

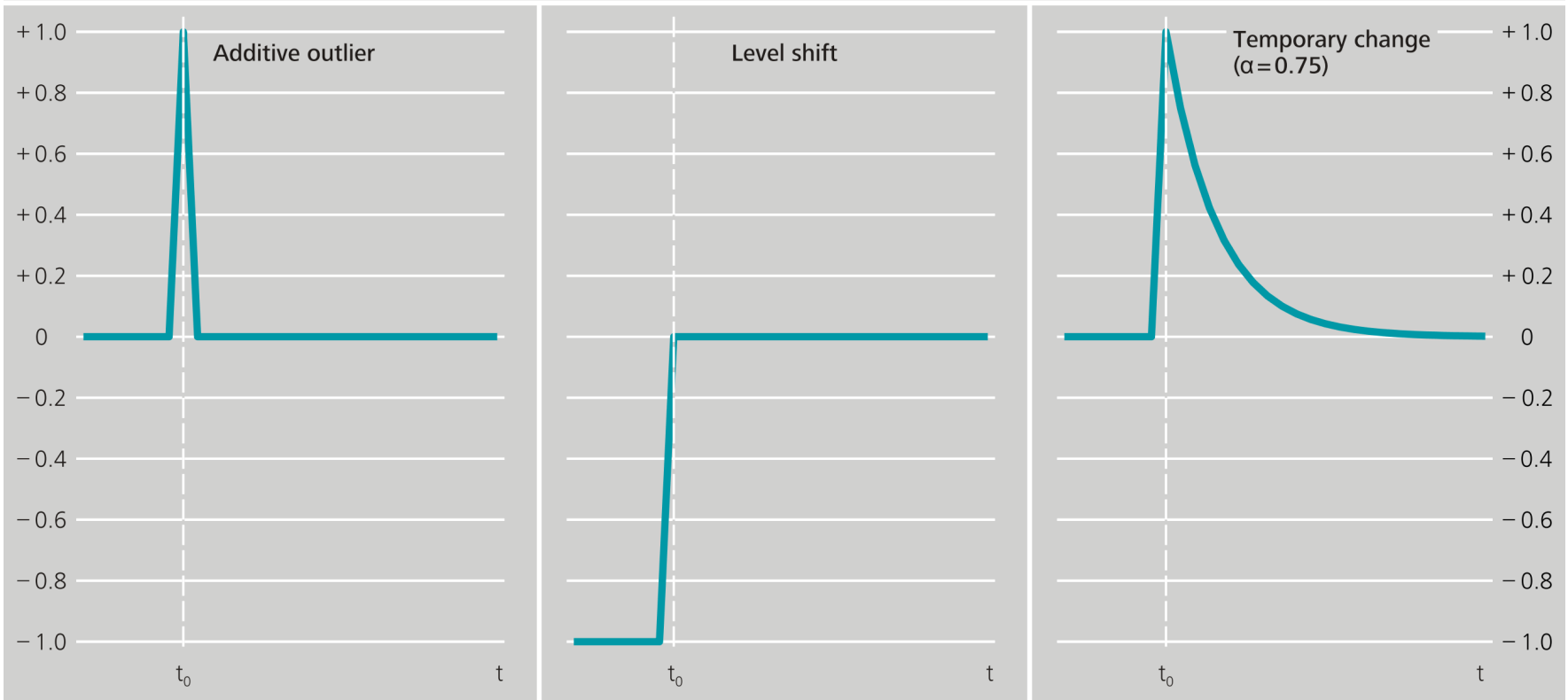
- Seasonal ARIMA model $\rightsquigarrow$ Dependence structure

Non-technical setup



Outliers (I/II)
Regression variables

Selected regARIMA outliers



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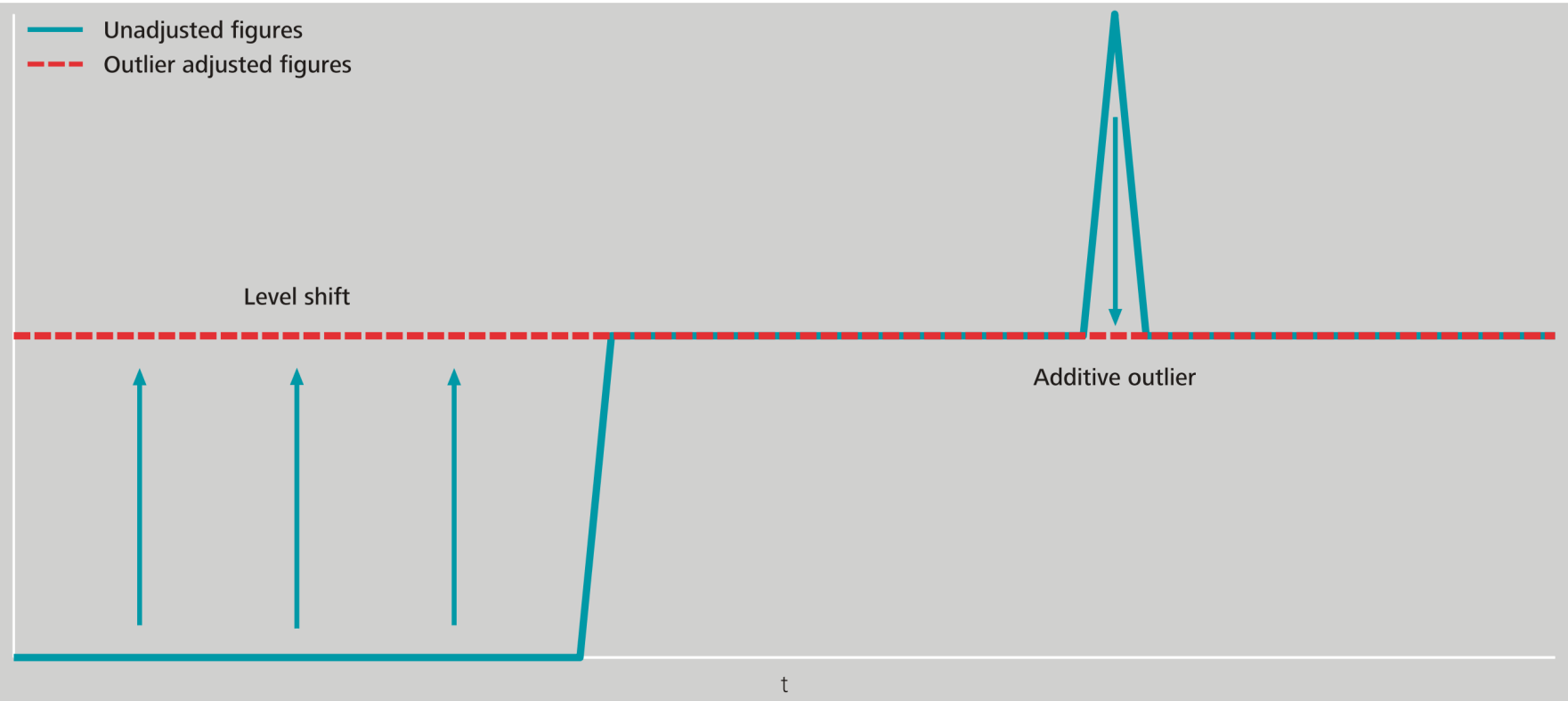
S3PR0039.Chart

Outliers (II/II)
Correction

Basic principle of temporary outlier removal



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S3PR0092.Chart

Calendar effects (I/V)
Types

Calendar effects = Seasonal effects + Structural effects

↓ ↓

Properties of the calendar that

recur every year | vary from year to year

↓ ↓

Seasonal | Calendar

Calendar effects (II/V)
Predefined regression variables

Selected variables

- Trading day contrasts $\rightsquigarrow$ Individual, common day-of-the-week effects
- Leap year $\rightsquigarrow$ February dummy
- Easter $\rightsquigarrow$ February/March/April share of pre-Easter period of interest (in days)

Pros & cons

- Advantage $\rightsquigarrow$ Easy use, instant results, indication
- Disadvantage $\rightsquigarrow$ No customisation, possible mismatch with national calendar

Calendar effects (III/V)
Estimated moving holiday effects

Price index for package holidays
2010 = 100

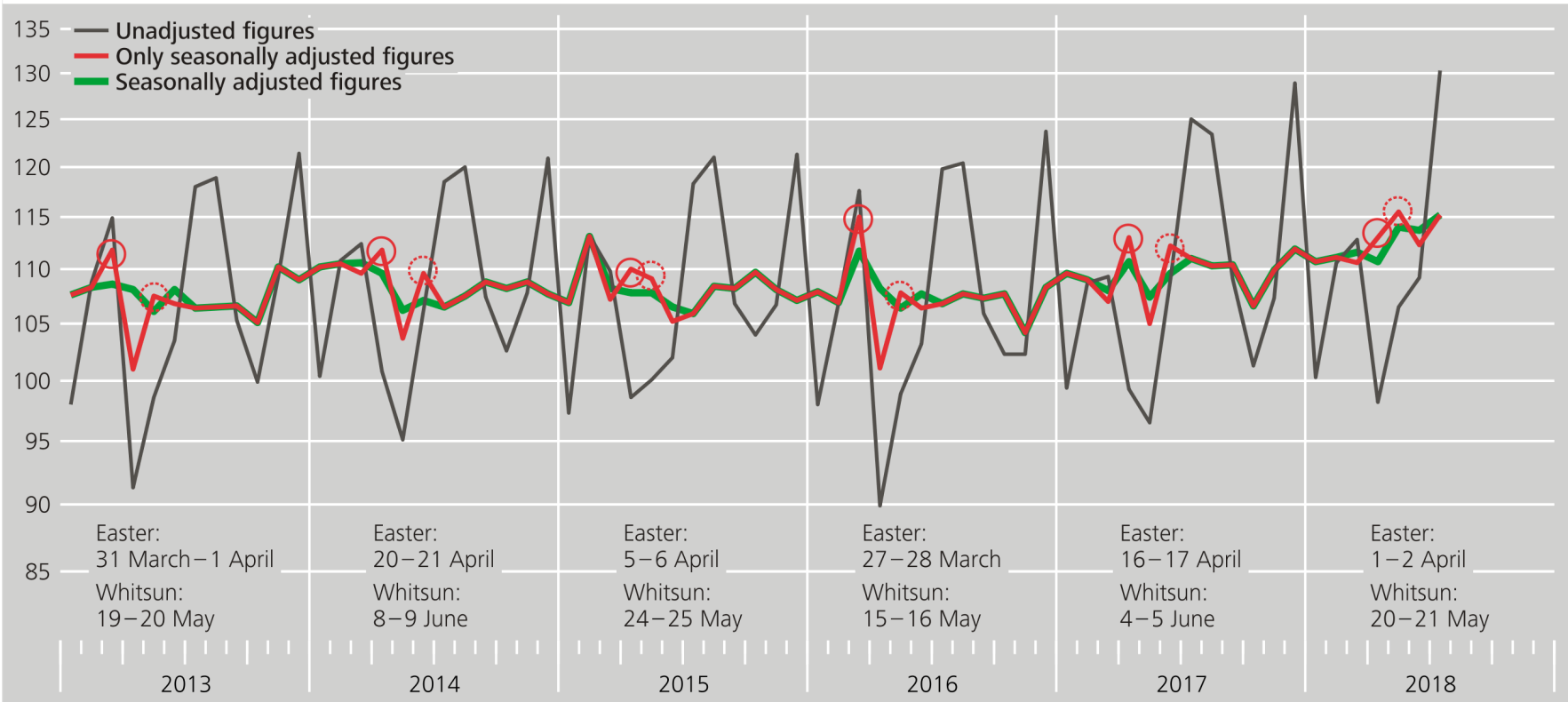
Location of ...	Parameter estimate [1)]	Standard error estimate	t-value
Easter Sunday in ...			
March	0.0381	0.00731	5.21
April	0.0881	0.00621	14.19
Whit Sunday in ...			
May/June	0.0358	0.00378	9.46

1 The location of Easter Sunday or of Whit Sunday in a month leads to an average rise in consumer prices for package holidays of . . . $\times$ 100 % per month.

Calendar effects (IV/V)
Permanent removal

Price index for package holidays

2010 = 100, log scale



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Calendar effects (V/V)

Further aspects: calendar adjustment in official statistics

Criterion [1)]	Average impact of Working days	Bridge days	School holidays	Weather
Estimated effect ...				
significant	Yes	Yes	Yes	Yes
plausible	Yes	Yes	No	Yes
Majority of adjusted figures plausible	Yes	Yes	Yes	No
Systematic over-/under-adjustment irrelevant	Yes	No	No	No
Catch-up effects quantifiable	Yes	No	No	No

1 As described in Item 2.6 of ESS Guidelines on Seasonal Adjustment, 2015 edition.

ARIMA model

Non-seasonal/seasonal operators

- Stationary autoregressive $\rightsquigarrow$ AR/SAR
- Differencing $\rightsquigarrow$ D/SD
- Invertible moving average $\rightsquigarrow$ MA/SMA

White noise (WN)

- Mean $\rightsquigarrow$ Zero
- Variance $\rightsquigarrow$ Finite, constant
- Dependence structure $\rightsquigarrow$ Zero (all lags)

Non-technical setup

Disturbances of regression equation

$$\downarrow$$

$$\text{AR} \circ \text{SAR} \circ \text{D} \circ \text{SD} \circ \text{B}\,1 = \text{MA} \circ \text{SMA} \circ \text{WN}$$

$$\downarrow \quad \downarrow \quad \downarrow \quad \downarrow \qquad\qquad \downarrow \quad \downarrow$$

$$p \quad P \quad d \quad D \qquad\qquad q \quad Q$$

$$\downarrow \quad \downarrow \quad \downarrow \quad \downarrow \qquad\qquad \downarrow \quad \downarrow$$

Order identification & parameter estimation

Airline model (I/III)
Definition

$$(1-B)\left(1-B^{12}\right)z_t = (1-\theta_1 B)\left(1-\Theta_1 B^{12}\right)\varepsilon_t$$

Notations

- $B \rightsquigarrow$ Backshift operator, i.e. $B^k z_t = z_{t-k}$
- $-1 \leqslant \theta_1, \Theta_1 \leqslant 1$
- Short $\rightsquigarrow (pdq)(PDQ) = (011)(011)$

Interpretation

- Θ_1 close to one/zero $\rightsquigarrow$ Stable/unstable seasonality
- θ_1 close to one/zero (given Θ_1) $\rightsquigarrow$ Stable/unstable trend

Airline model (II/III)
Explanation: model for input series

$$z_t = a + bt + s_t + \text{residual}_t$$

Deterministic components

- Trend
- Seasonal factors

Consequence

$$(1 - B)\left(1 - B^{12}\right)\text{residual}_t = (1 - \theta_1 B)\left(1 - \Theta_1 B^{12}\right)\varepsilon_t$$

Airline model (III/III)
Application: choice of Henderson & seasonal filters in X-11

θ_1	Θ_1 0.95		0.80		0.70		0.60	
0.95	s3x15	H23	s3x15	H23	s3x9	H23	s3x5	H23
0.80	s3x15	H23	s3x15	H23	s3x9	H23	s3x5	H23
0.70	s3x15	H23	s3x15	H23	s3x9	H23	s3x5	H23
0.60	s3x15	H17	s3x15	H17	s3x9	H17	s3x5	H17
0.50	s3x15	H13	s3x15	H13	s3x9	H13	s3x5	H13
0.40	s3x15	H13	s3x15	H13	s3x9	H13	s3x5	H13
0.20	s3x15	H9	s3x15	H9	s3x9	H9	s3x5	H9
0.00	s3x15	H9	s3x15	H9	s3x9	H9	s3x5	H9

θ_1	Θ_1 0.50		0.40		0.20		0.00	
0.95	s3x3	H23	s3x3	H23	s3x3	H23	s3x3	H23
0.80	s3x3	H23	s3x3	H23	s3x3	H23	s3x3	H23
0.70	s3x3	H23	s3x3	H23	s3x3	H23	s3x3	H23
0.60	s3x5	H23	s3x3	H23	s3x3	H23	s3x3	H23
0.50	s3x5	H13	s3x3	H17	s3x3	H23	s3x3	H23
0.40	s3x5	H13	s3x3	H13	s3x3	H17	s3x3	H23
0.20	s3x3	H9	s3x3	H9	s3x3	H13	s3x3	H23
0.00	s3x3	H9	s3x3	H9	s3x3	H9	s3x3	H23

Source: R Depoutot & C Planas (1998), Comparing Seasonal Adjustment and Trend Extraction Filters with Application to a Model-Based Selection of X11 Linear Filters, Discussion Paper No 9/1998/A/9, Eurostat.

References (I/II)
Box-Cox transformation & outliers

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- G E P Box & G C Tiao (1975), Intervention Analysis with Applications to Economic and Environmental Problems, Journal of the American Statistical Association 70 (349), 70-79.
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Calendar variation

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