DEUTSCHE BUNDESBANK
EUROSYSTEM

Elementary seasonal adjustment of economic data with JDemetra+: Module III – X-11 approach

Dr Karsten Webel / Deutsche Bundesbank, DG Statistics

Virtual Seminar Series, 19-23 October 2020

Aims

Theory

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

Application

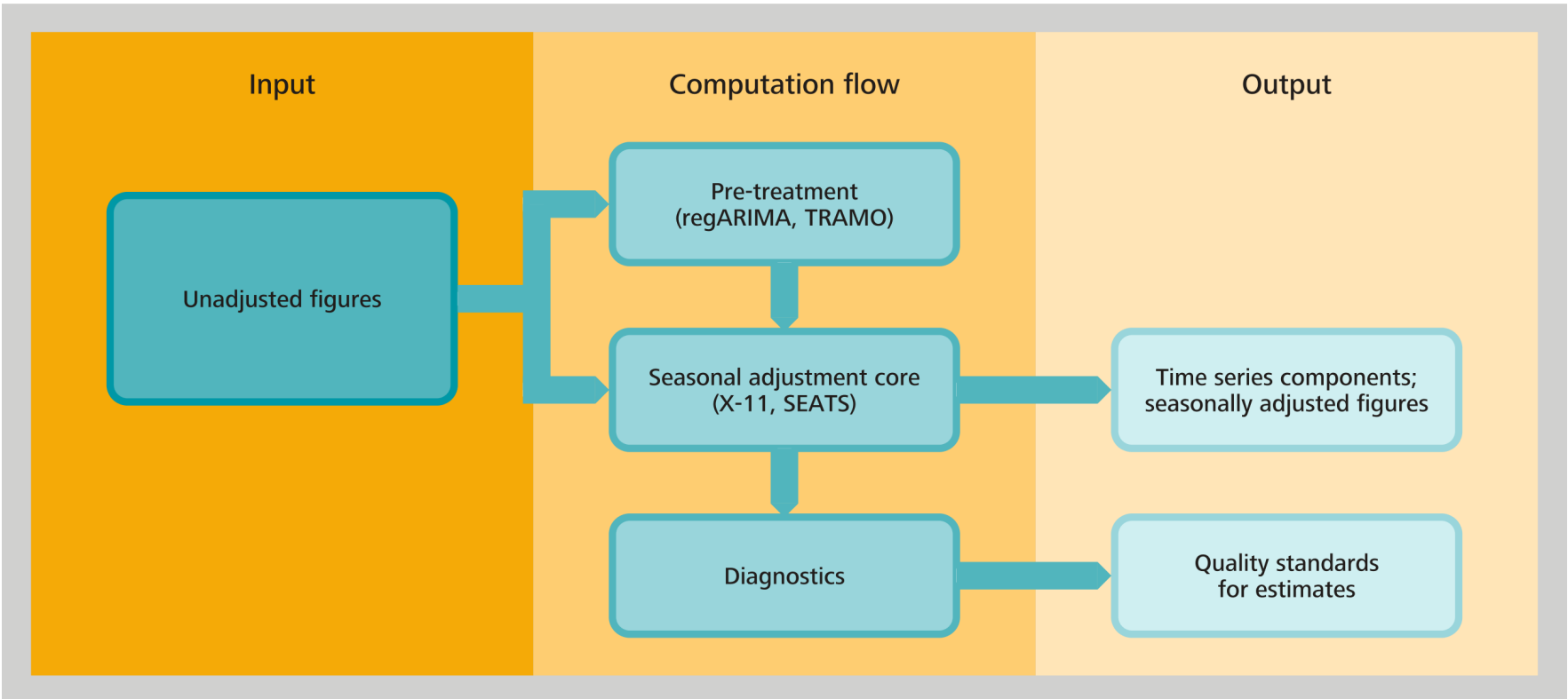
- Software $\rightsquigarrow$ JDemetra+ (JD+)
- Specification $\rightsquigarrow$ Options
- Results $\rightsquigarrow$ Interpretation, quality assessment

Discussion

- Your questions $\rightsquigarrow$ Practical problems

Road map

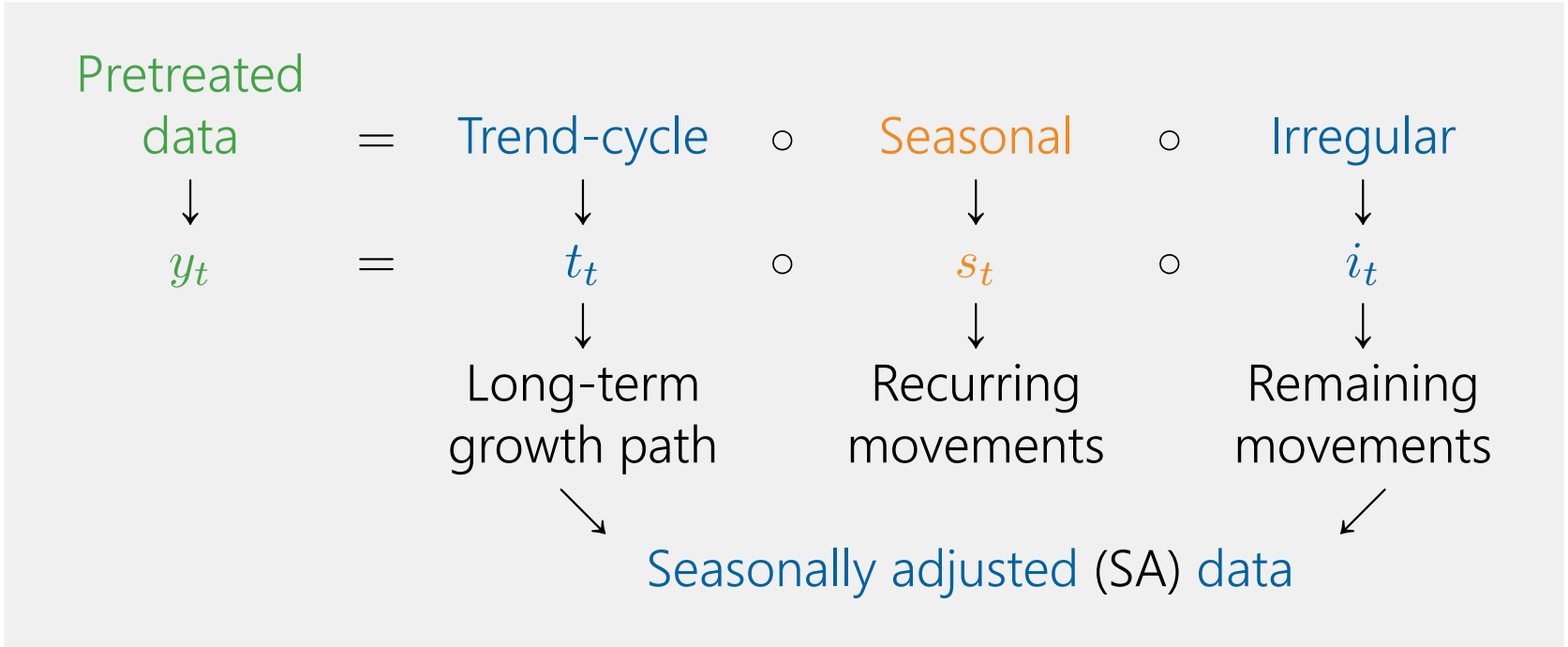
Structure of JDemetra+



Deutsche Bundesbank

S3PR0018B.Chart

Unobserved component (UC) model



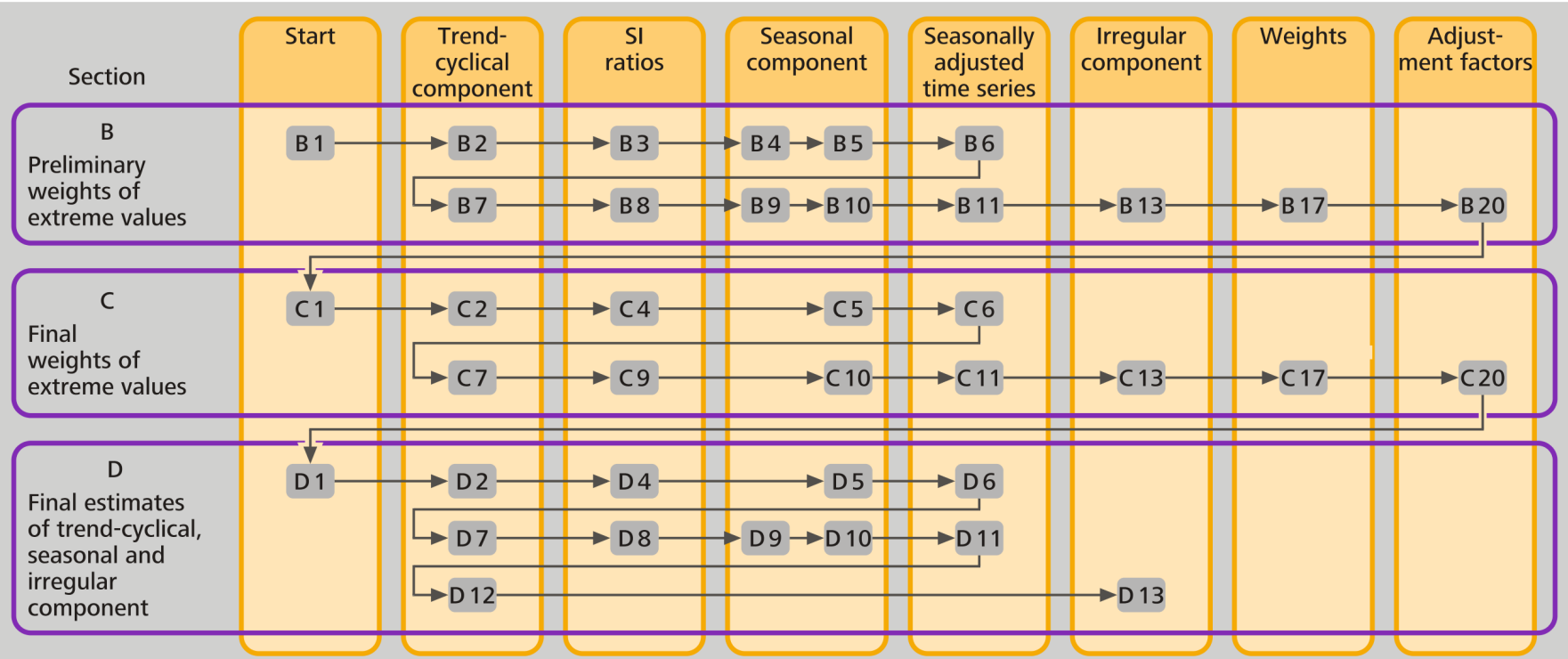
Decomposition

- Multiplicative $\rightsquigarrow$ Seasonal proportional to trend-cycle
- Additive $\rightsquigarrow$ Seasonal independent of level of trend-cycle

Strategy (I/II)

Basic principle of the X-11 seasonal adjustment algorithm in JDemetra+*

Workflow diagram



* In X-13 terminology, Section A is solely devoted to the treatment of outliers and calendar effects within a regARIMA modelling framework which is done prior to the application of the X-11 core.

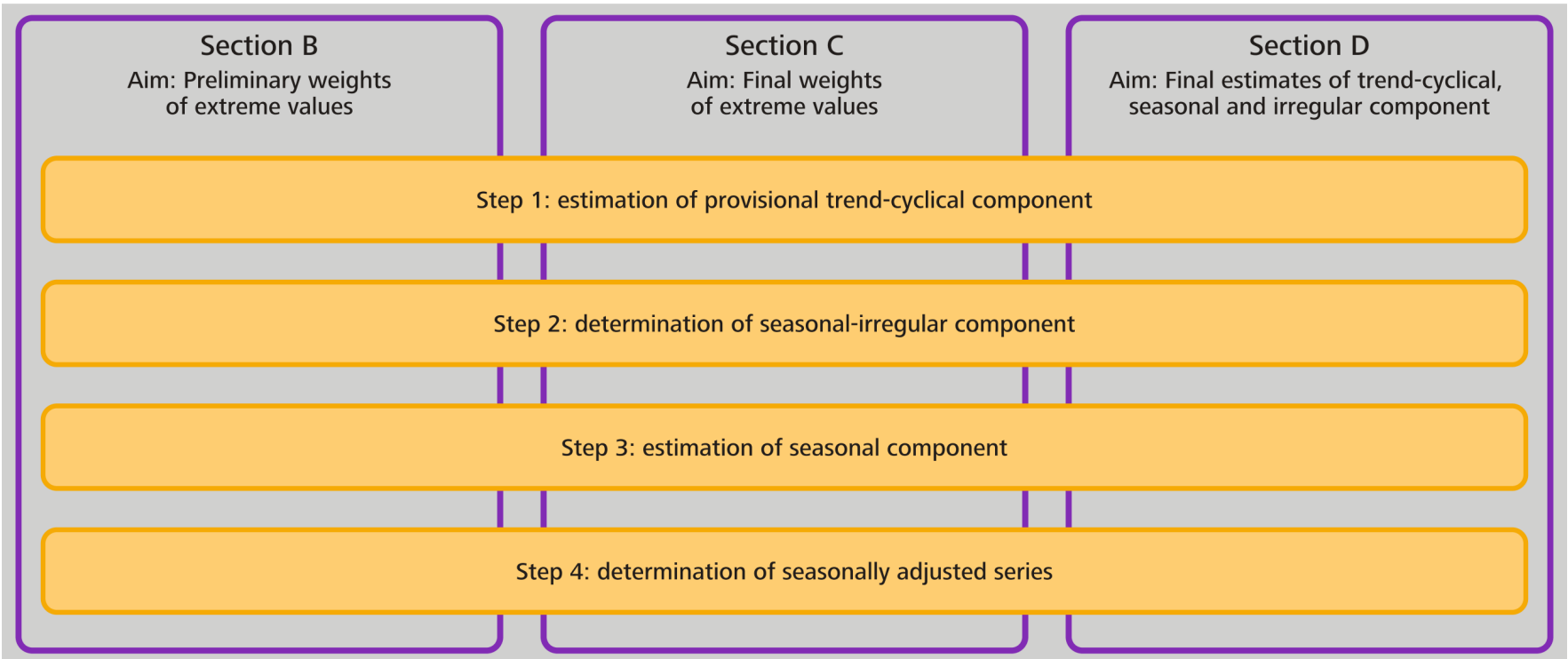
Deutsche Bundesbank

S3PR0037D.Chart

Strategy (II/II)

Basic principle of the X-11 seasonal adjustment algorithm*

Workflow diagram, simplified version



***** In X-13 terminology, Section A is solely devoted to the treatment of outliers and calendar effects within a regARIMA modelling framework which is done prior to the application of the X-11 core.

Deutsche Bundesbank

S3PR0023.Chart

Step 1: provisional trend-cycle

Preliminary trend-cycle

$$\hat{t}_t = \frac{1}{24} y_{t-6} + \frac{1}{12} y_{t-5} + \cdots + \frac{1}{12} y_t + \cdots + \frac{1}{12} y_{t+5} + \frac{1}{24} y_{t+6}$$

Interpretation

- Modified unadjusted figures $\rightsquigarrow$ Smoothed by centred moving average (MA) over 13 months

Boundary issue

- MA application $\rightsquigarrow$ 6 missing values (at either end)

Step 2: seasonal-irregular component

Preliminary seasonal-irregular (SI)

$$(\widehat{si})_t = \frac{y_t}{\hat{t}_t}$$

Interpretation

- Modified unadjusted figures $\rightsquigarrow$ Removal of preliminary trend-cycle

Step 3: seasonal component (I/III)

Preliminary seasonal

$$\hat{s}_t = \frac{1}{9}(\widehat{si})_{t-24} + \frac{2}{9}(\widehat{si})_{t-12} + \frac{3}{9}(\widehat{si})_t + \frac{2}{9}(\widehat{si})_{t+12} + \frac{1}{9}(\widehat{si})_{t+24}$$

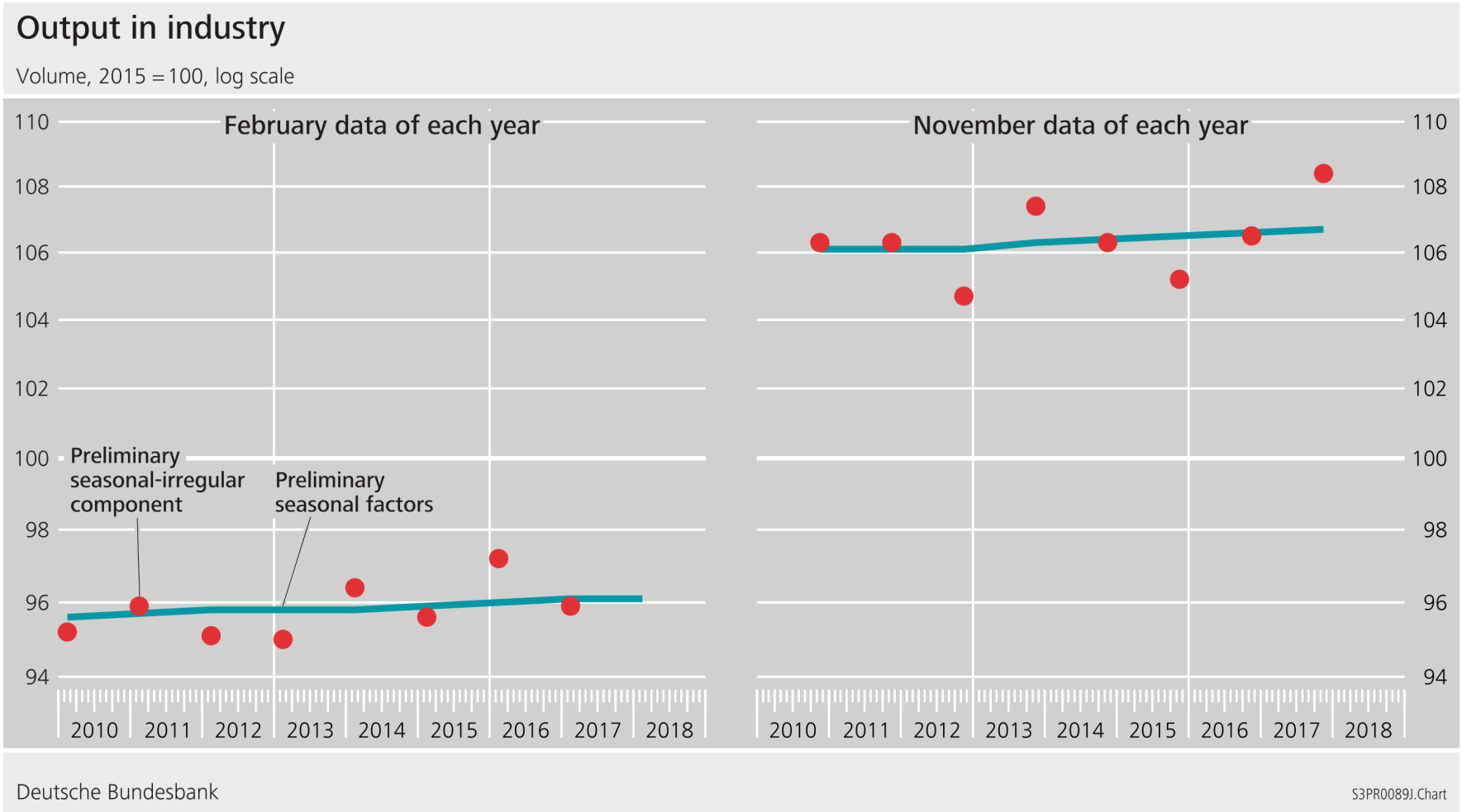
Interpretation

- Preliminary seasonal-irregular $\rightsquigarrow$ Smoothed by 3×3 seasonal filter within each month

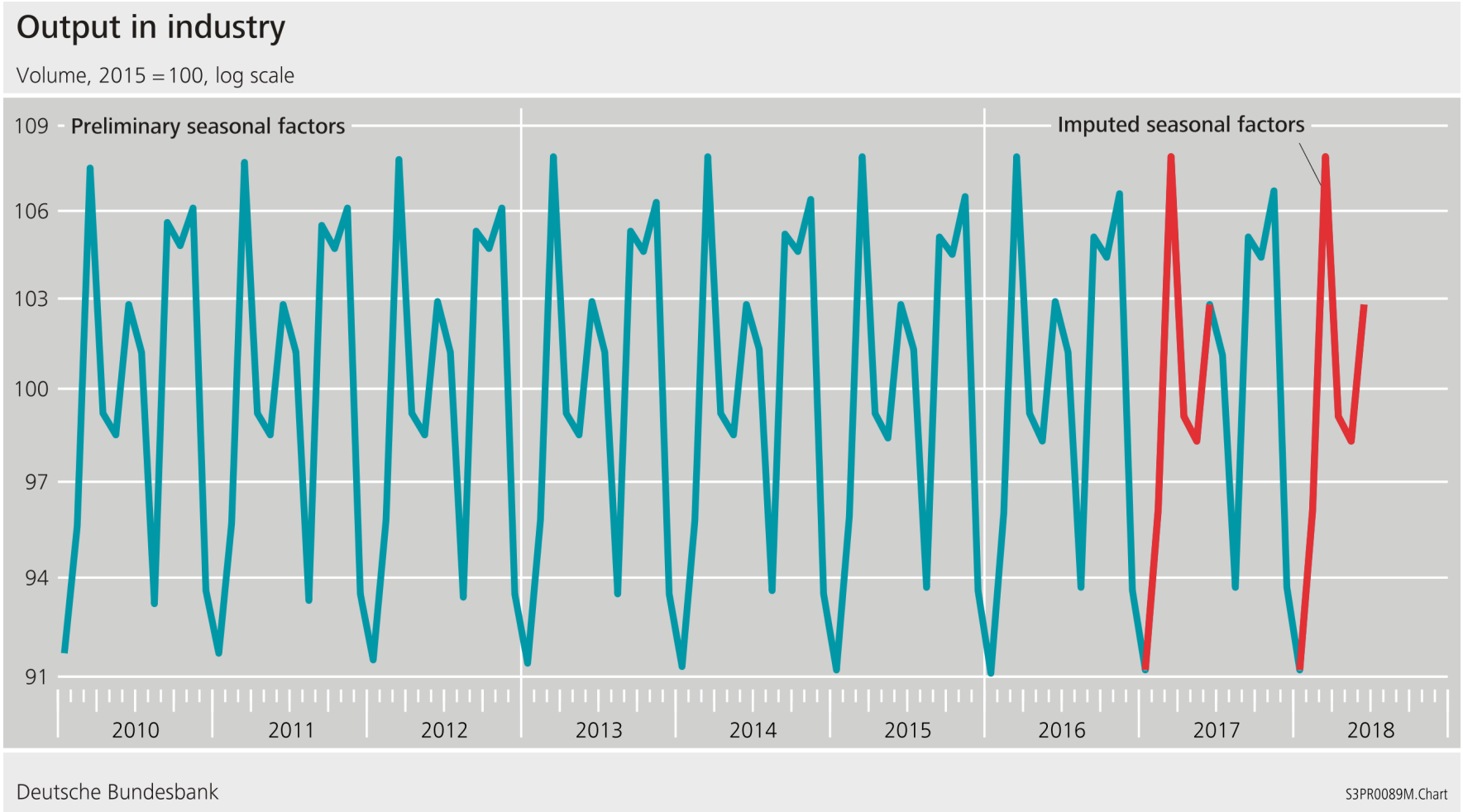
Boundary issue

- Missing values $\rightsquigarrow$ "Copy-paste" imputation

Step 3: seasonal component (II/III)



Step 3: seasonal component (III/III)



Step 4: seasonally adjusted series

Preliminary seasonally adjusted figures

$$\hat{y}_t^{(sa)} = \frac{y_t}{\hat{s}_t}$$

Interpretation

- Modified unadjusted figures $\rightsquigarrow$ Removal of preliminary seasonal

Next loop

Final UC estimates

- Preliminary estimates $\rightsquigarrow$ Refinement

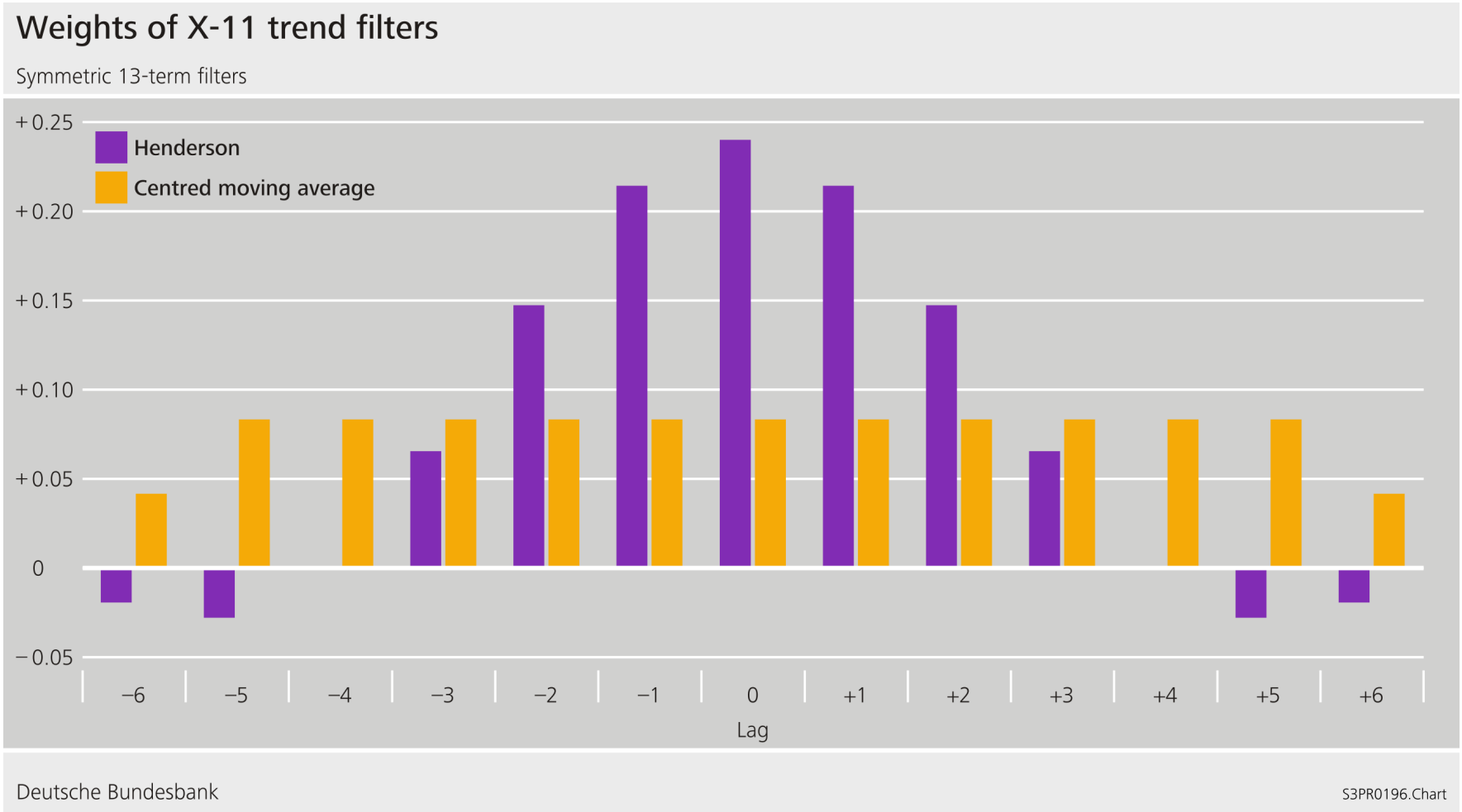
User customisation

- Options $\rightsquigarrow$ Extended
- Trend filters $\rightsquigarrow$ Henderson types
- Seasonal filters $\rightsquigarrow$ Period-specific
- Extreme SI ratios $\rightsquigarrow$ Down-weighting, replacement

Boundary issue

- Symmetric Henderson & seasonal filters $\rightsquigarrow$ Asymmetric non-centred variants

Henderson filters (I/II)



Henderson filters (II/II)

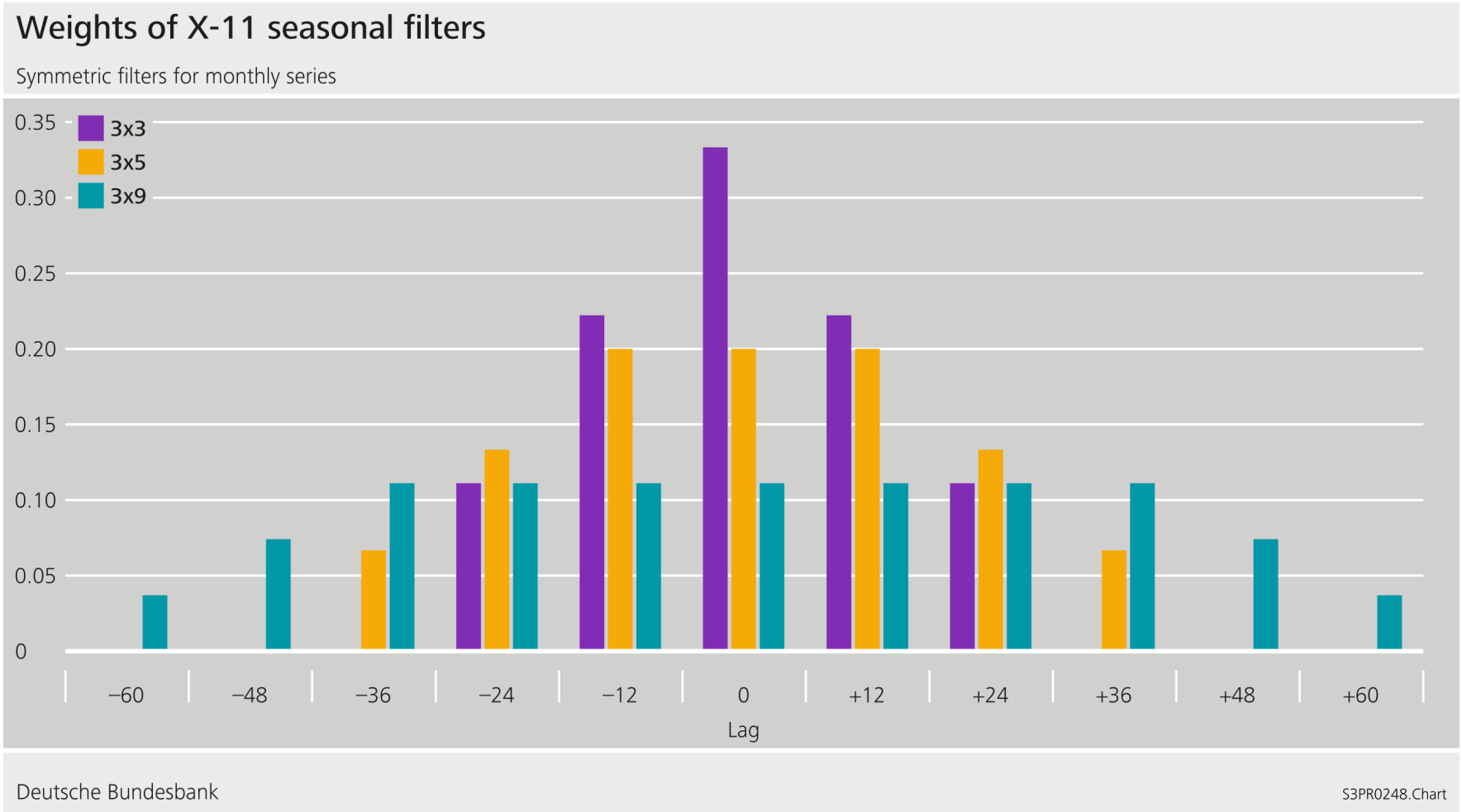
	Automatic selection rule		
I/C*	$[0, 1)$	$[1, 3.5)$	$[3.5, \infty)$
Monthly data	9-term	13-term	23-term
Quarterly data	5-term	5-term	7-term

* I/C is the ratio between the average absolute period-on-period changes of a temporary irregular and a temporary trend-cyclical component.

Interpretation

- I/C large $\rightsquigarrow$ Dominance of irregular (i.e. long filter)
- I/C small $\rightsquigarrow$ Dominance of trend-cycle (i.e. short filter)

Seasonal filters (I/III)



Seasonal filters (II/III)

	Automatic selection rule				
I/S*	$[0, 2.5)$	$[2.5, 3.5]$	$(3.5, 5.5)$	$[5.5, 6.5]$	$(6.5, \infty)$
Monthly data	3×3	☹	3×5	☹	3×9
Quarterly data	3×3	☹	3×5	☹	3×9

* I/S is the ratio between the average absolute year-on-year changes of a temporary irregular and a temporary seasonal component. ☹ $\rightsquigarrow$ Maximum of five I/S recalculations under omission of the respective last year, application of the 3×5 seasonal filter if still no decision is found.

Interpretation

- I/S large $\rightsquigarrow$ Dominance of irregular (i.e. long filter)
- I/S small $\rightsquigarrow$ Dominance of seasonal (i.e. short filter)

Seasonal filters (III/III)

Seasonal factors (D 10) vs. SI ratios (D 8)

- Long-term evolution $\rightsquigarrow$ Reflection
- Current end $\rightsquigarrow$ Typical behaviour

Airline model

- Parameter estimates $\rightsquigarrow$ Guidance
- Details $\rightsquigarrow$ ARIMA part (Module II)

Additional information

- Data $\rightsquigarrow$ Length
- Seasonality $\rightsquigarrow$ Weak degree, changes (e.g. structural breaks)

Extreme SI ratios (I/IV)

Identification

- Irregular $\rightsquigarrow$ Large deviation from expectation
- Benchmark $\rightsquigarrow$ Moving standard deviation (σ_t)
- Tolerances $\rightsquigarrow$ Lower, upper σ-limit (L_σ, U_σ)

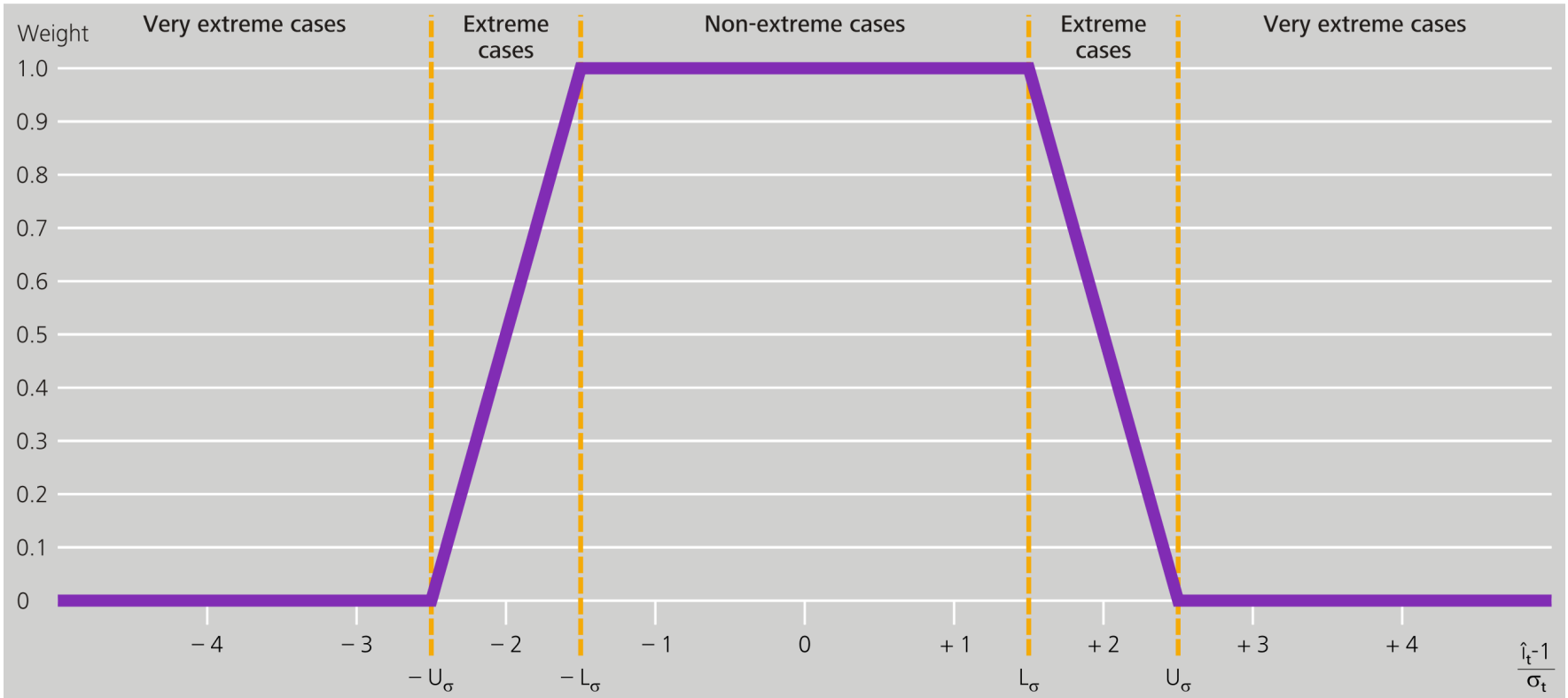
Replacement value (D 9)

- Extreme SI ratio $\rightsquigarrow$ Weight $\in [0, 1)$ (C 17)
- Four non-extreme SI ratios (same period) $\rightsquigarrow$ Weight $= 1$

Extreme SI ratios (II/IV)

Basic idea of weight assignment

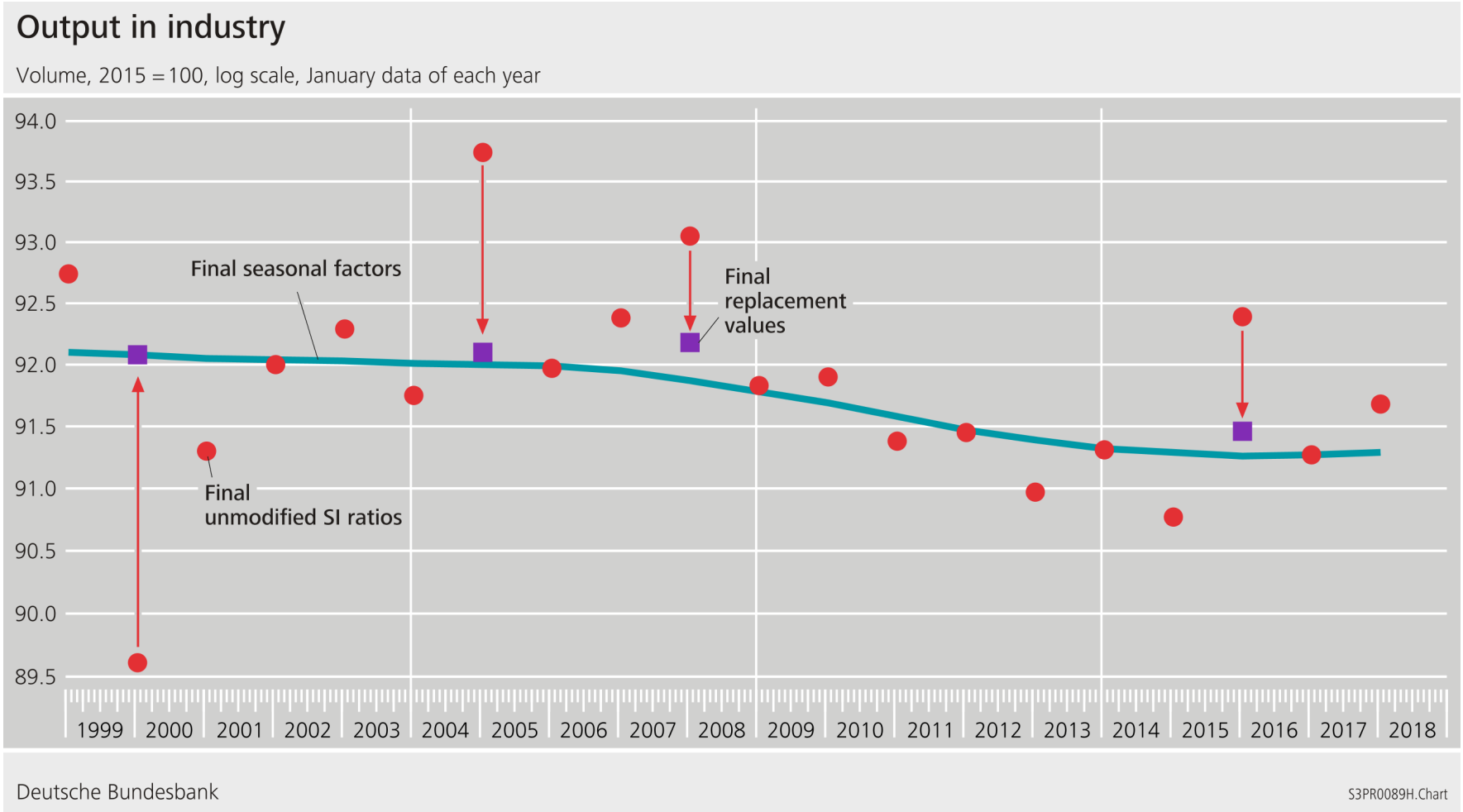
X-11 defaults



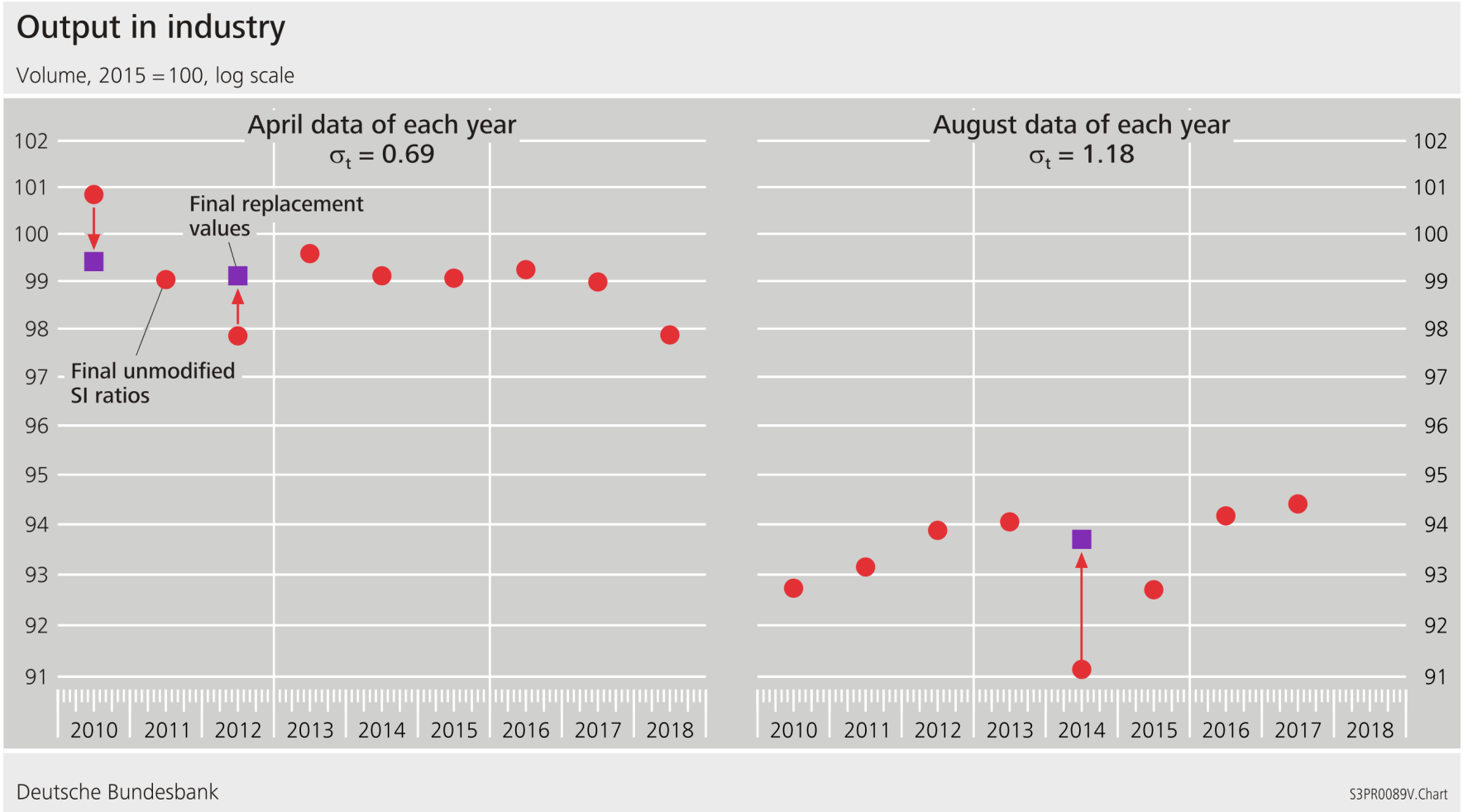
Deutsche Bundesbank

S3PR0022.Chart

Extreme SI ratios (III/IV)



Extreme SI ratios (IV/IV)



References (I/II)
First reading

- D F Findley, B C Monsell, W R Bell, M C Otto & B-C Chen (1998), New Capabilities and Methods of the X-12-ARIMA Seasonal-Adjustment Program, Journal of Business & Economic Statistics 16 (2), 127-152.
- D Ladiray & B Quenneville (2001), Seasonal Adjustment with the X-11 Method, Lecture Notes in Statistics Vol. 158, Springer, New York.
- J Shiskin & H Eisenpress (1957), Seasonal Adjustments by Electronic Computer Methods, Journal of the American Statistical Association 52 (280), 415-449.
- J Shiskin, A H Young & J C Musgrave (1967), The X-11 Variant of the Census Method II Seasonal Adjustment Program, Technical Paper No. 15, US Department of Commerce, Bureau of the Census, Washington, DC.

References (II/II)
Deutsche Bundesbank

- Deutsche Bundesbank (1970), Seasonal adjustment by the Census Method, Monthly Report 22 (3), 37-41.
- Deutsche Bundesbank (1991), Data, adjusted for seasonal and working-day variations, on the expenditure components of GNP, Monthly Report 43 (4), 35-40.
- Deutsche Bundesbank (1999), The changeover from the seasonal adjustment method Census X-11 to Census X-12-ARIMA, Monthly Report 51 (9), 39-50.
- Deutsche Bundesbank (2018), Gradual changeover to JDemetra+ software for seasonal adjustment of the official statistics, Monthly Report 70 (5), 50.