DEUTSCHE BUNDESBANK
EUROSYSTEM

Seasonal adjustment of economic data
Quality assessment

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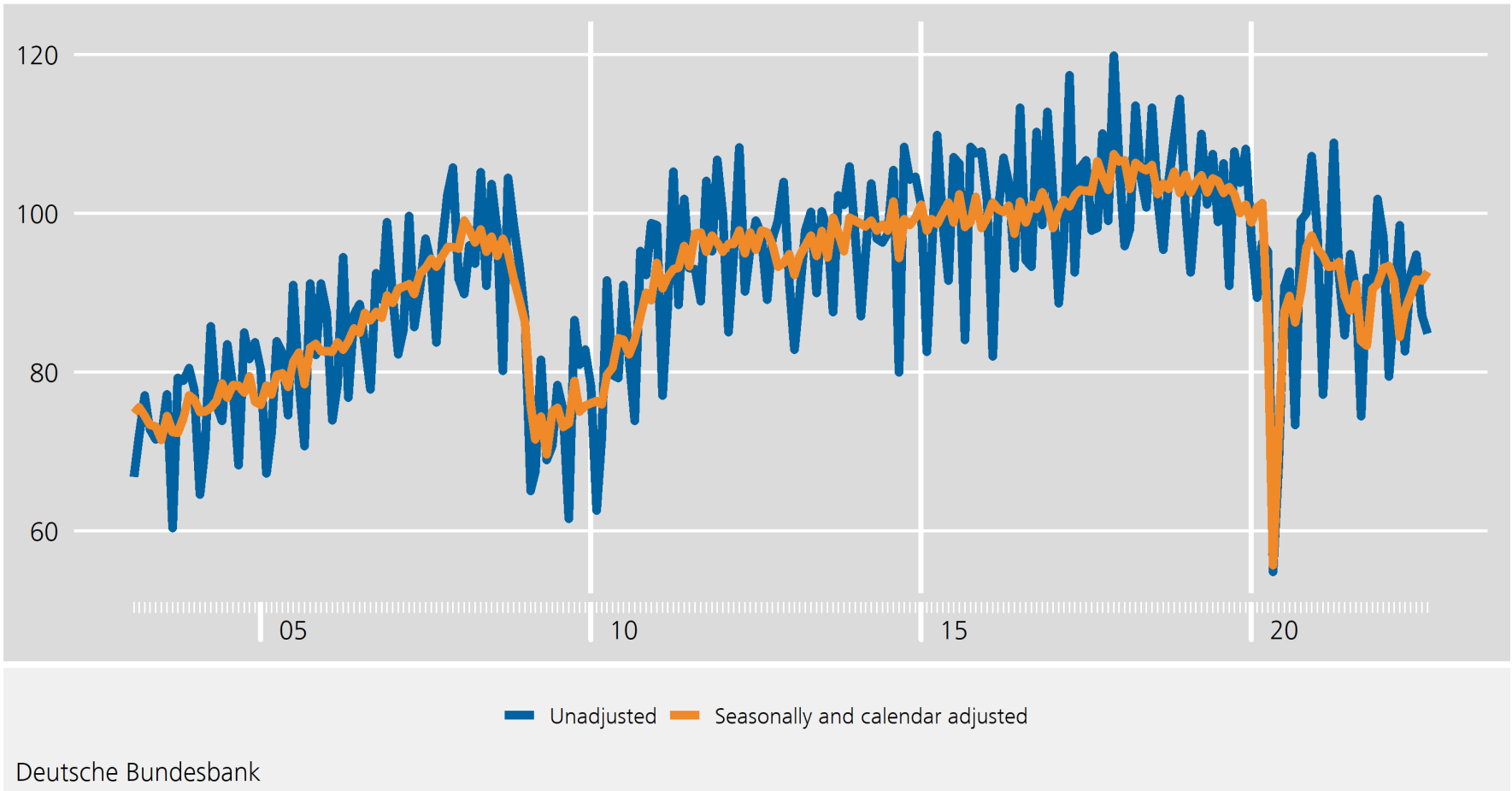
Seasonal adjustment, 1 February January 2023

Visual inspection

Output in the production sector / Germany / Intermediate goods

Good Adjustment



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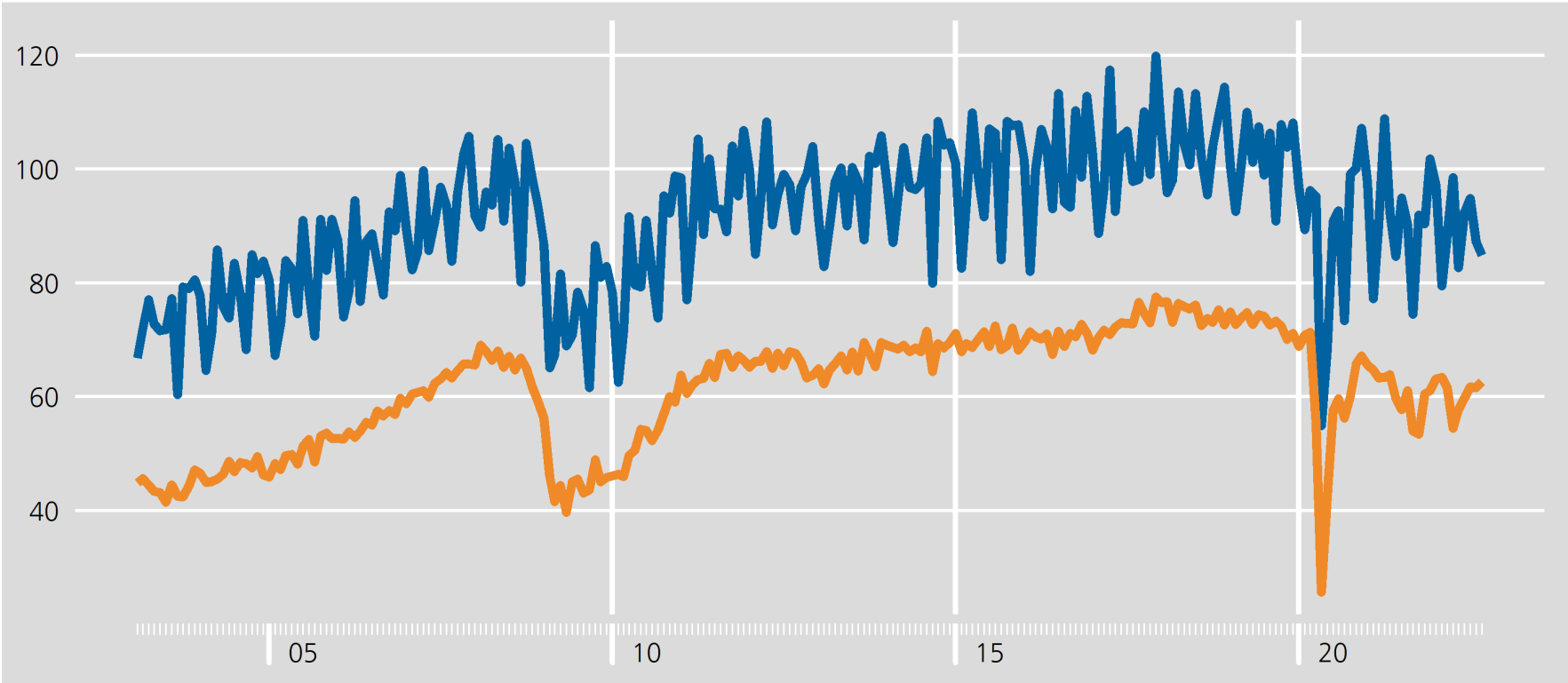
Visual inspection

Output in the production sector / Germany / Intermediate goods

Bad adjustment



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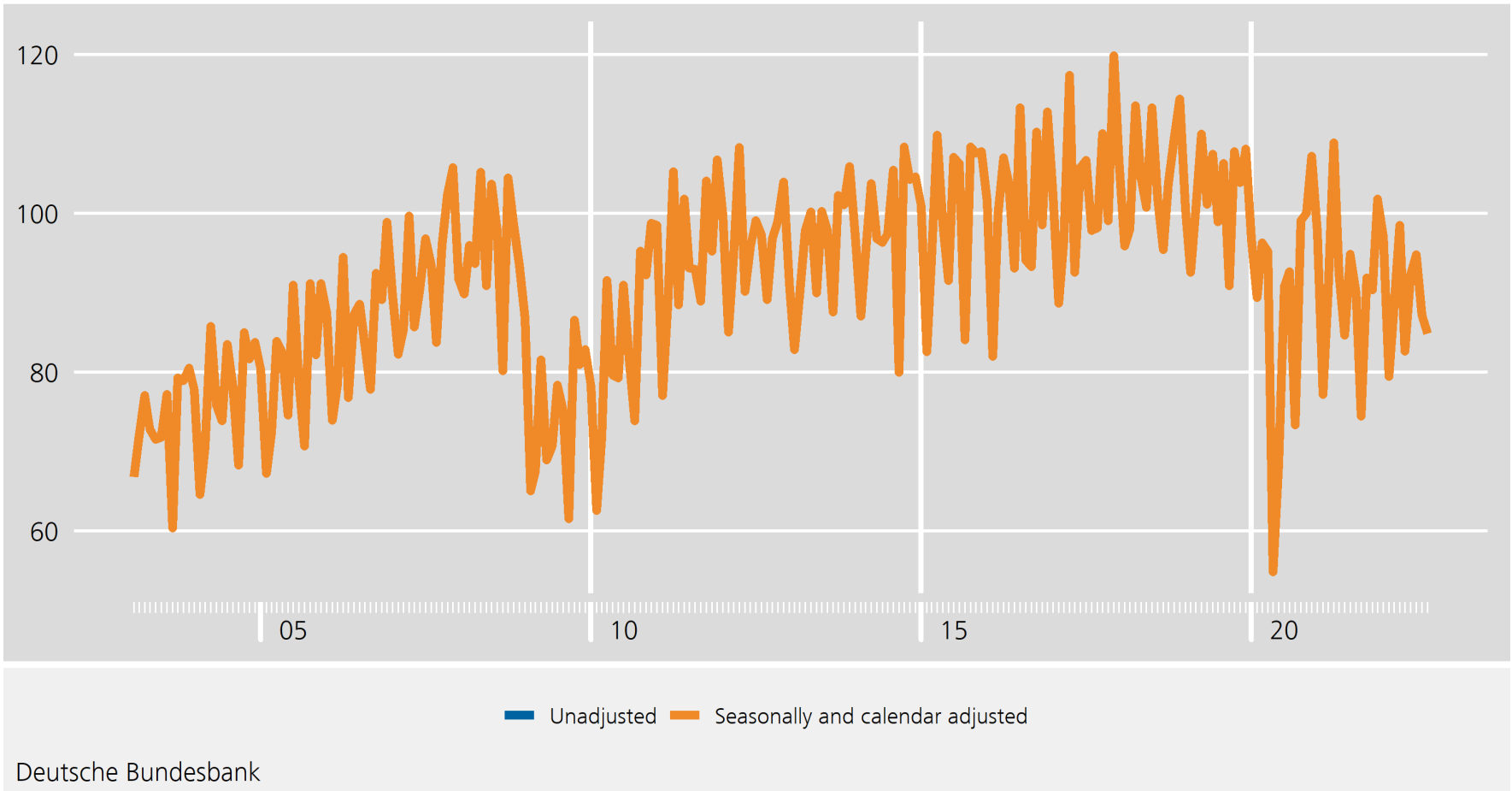
Visual inspection

Output in the production sector / Germany / Intermediate goods

Bad adjustment



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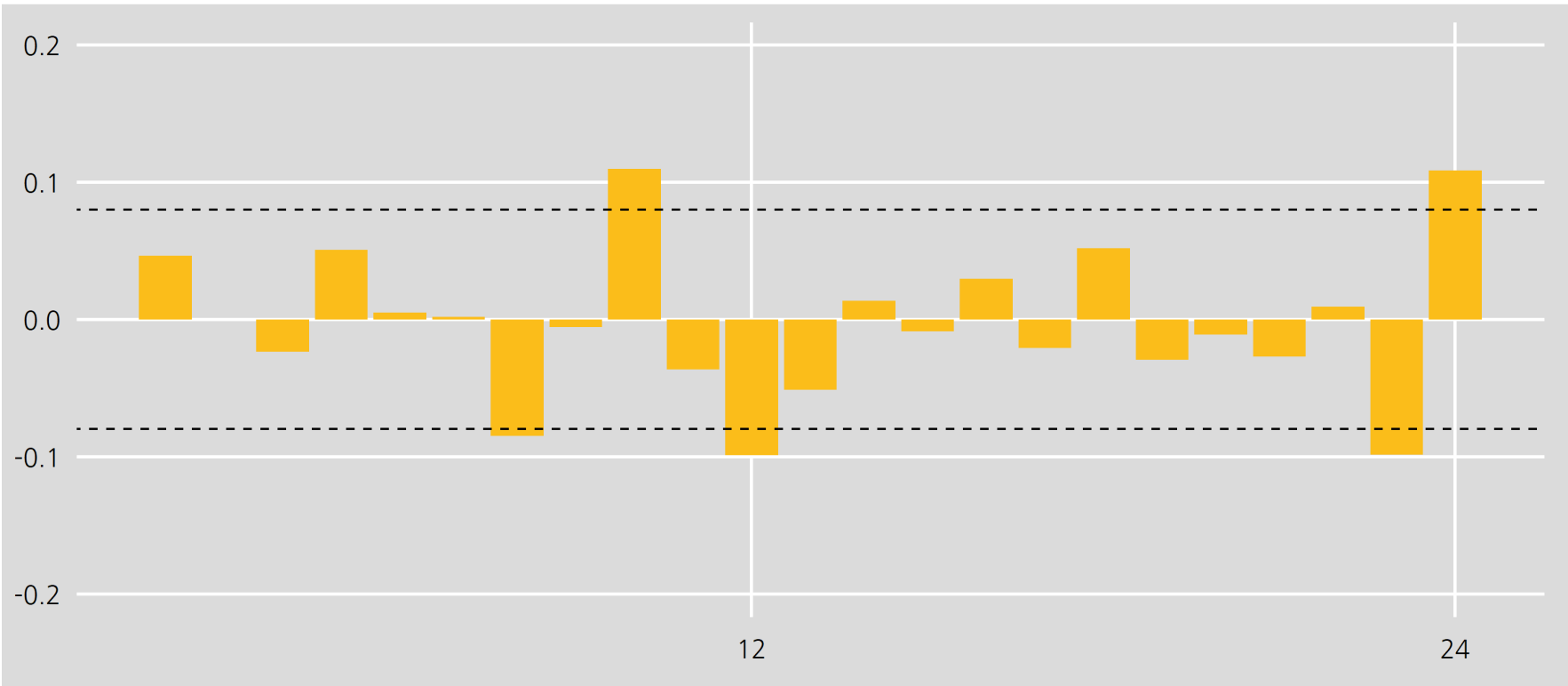
Evaluating the ARIMA model
ACF

Auto-correlation function, ARIMA(0,1,1)(0,1,1) with regressors

Output in the production sector / Germany / Intermediate goods



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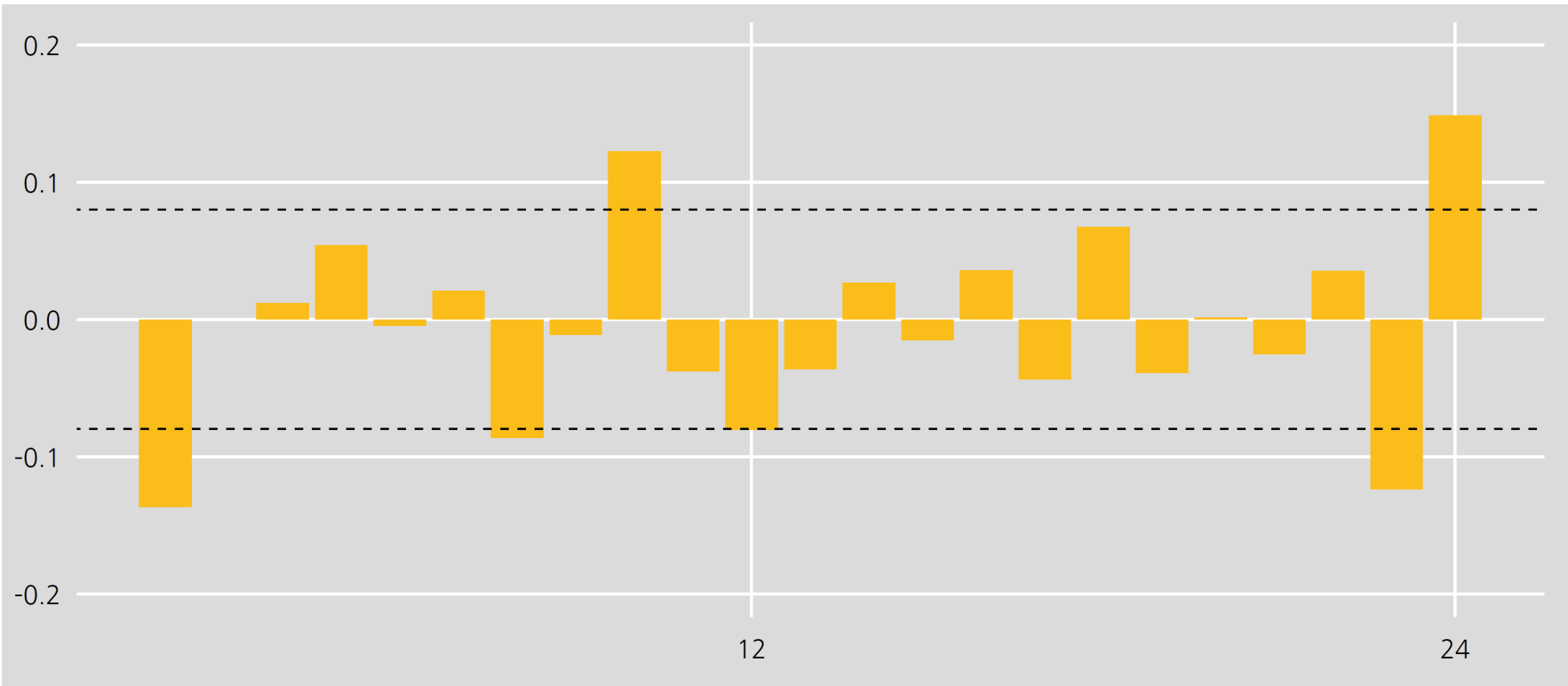
Evaluating the ARIMA model
ACF for inadequate model

Auto-correlation function, ARIMA(0,1,0)(0,1,1) with regressors

Output in the production sector / Germany / Intermediate goods



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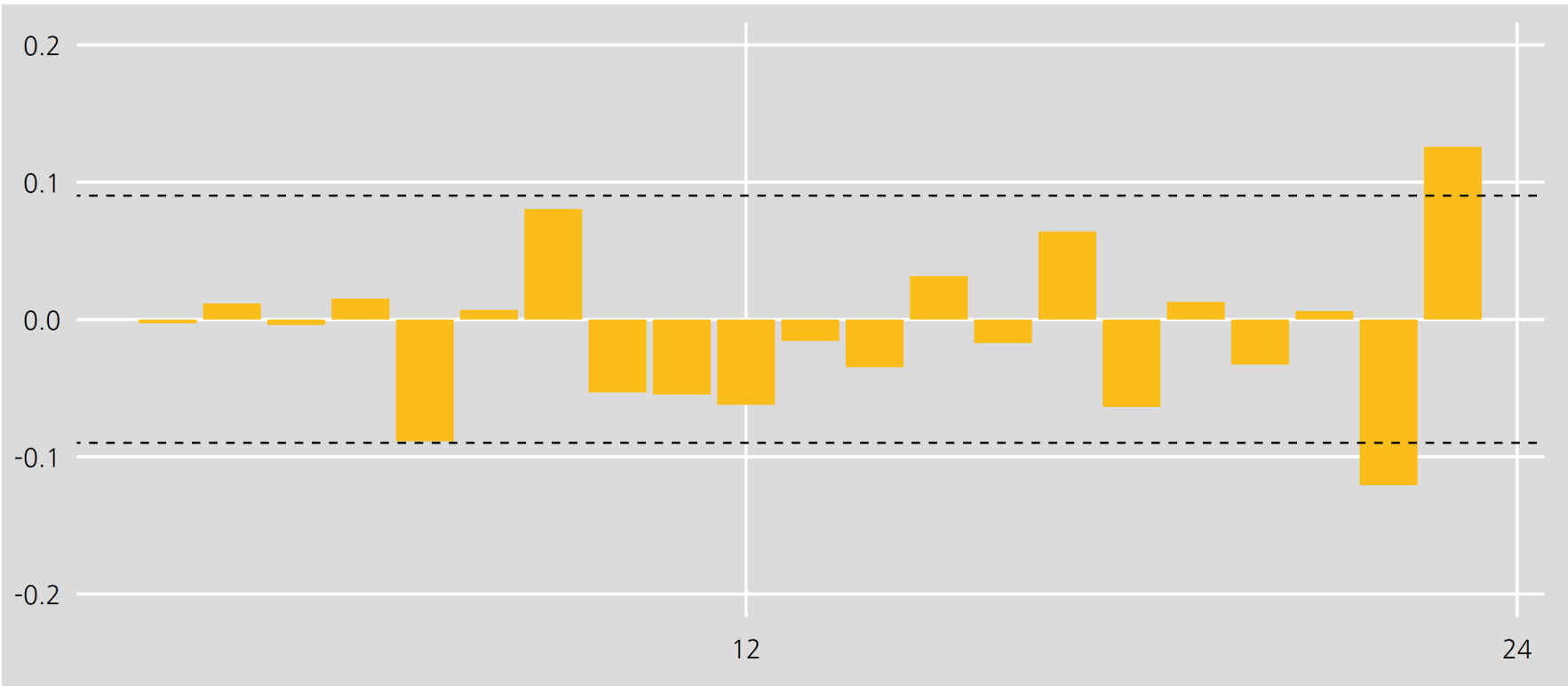
Evaluating the ARIMA model
PACF

Partial auto-correlation function, ARIMA(0,1,1)(0,1,1) with regressors

Output in the production sector / Germany / Intermediate goods



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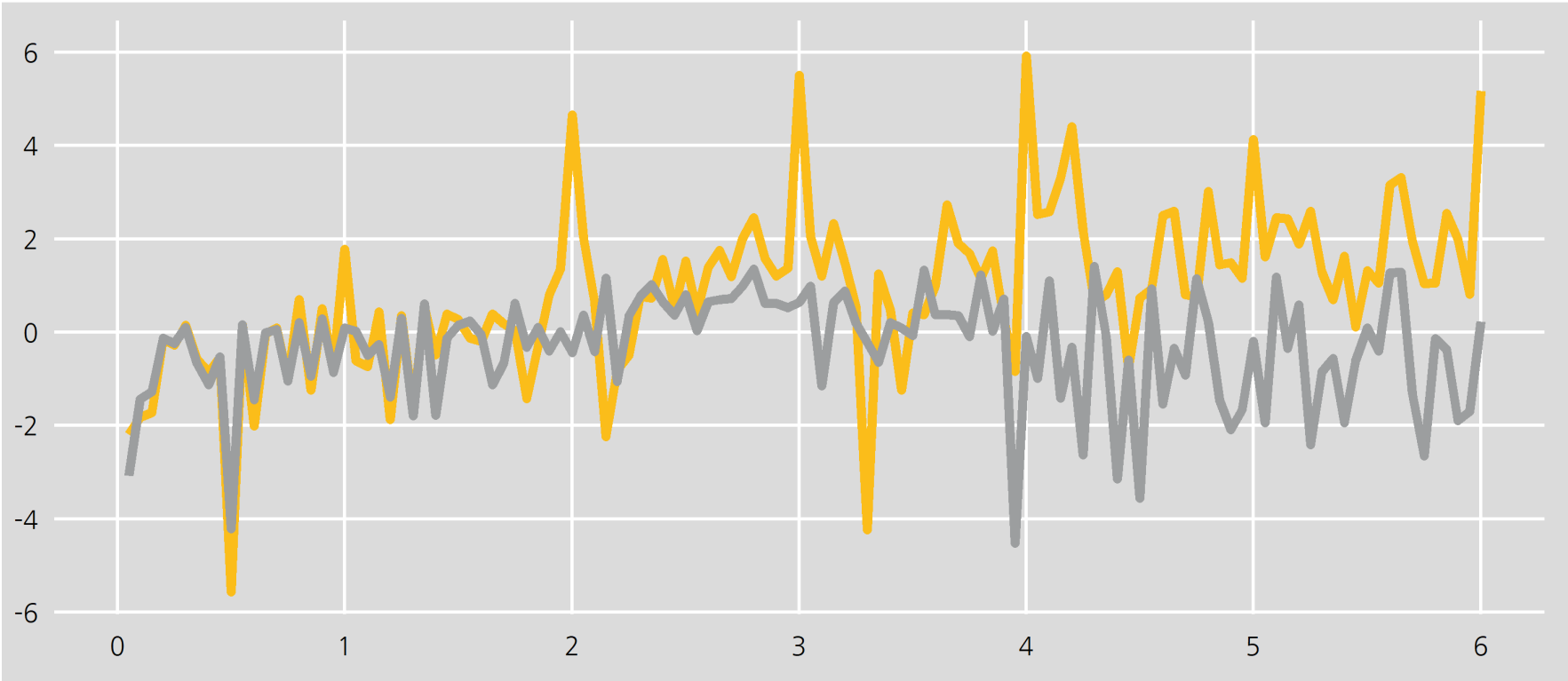
Periodogram

Periodogram of the differenced series

Output in the production sector / Germany / Intermediate goods



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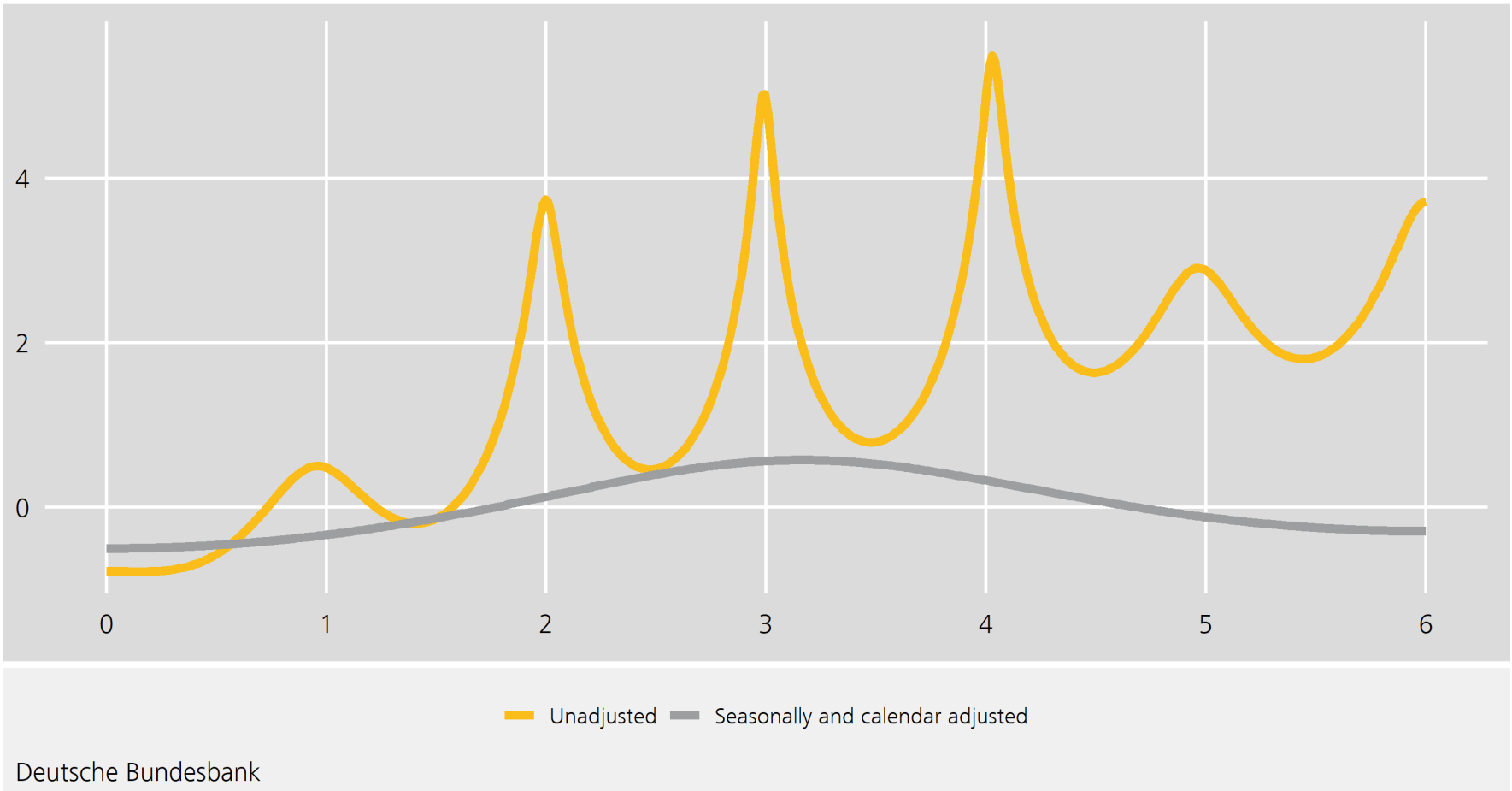
AR Spectra

AR-spectrum of the differenced series

Output in the production sector / Germany / Intermediate goods



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Spectra

Periodogram and AR Spectrum applied to

- Original Series (not in JD)
- Residuals
- Irregular
- Seasonally adjusted series

Seasonality tests in JD+ (I/VII)
Overview

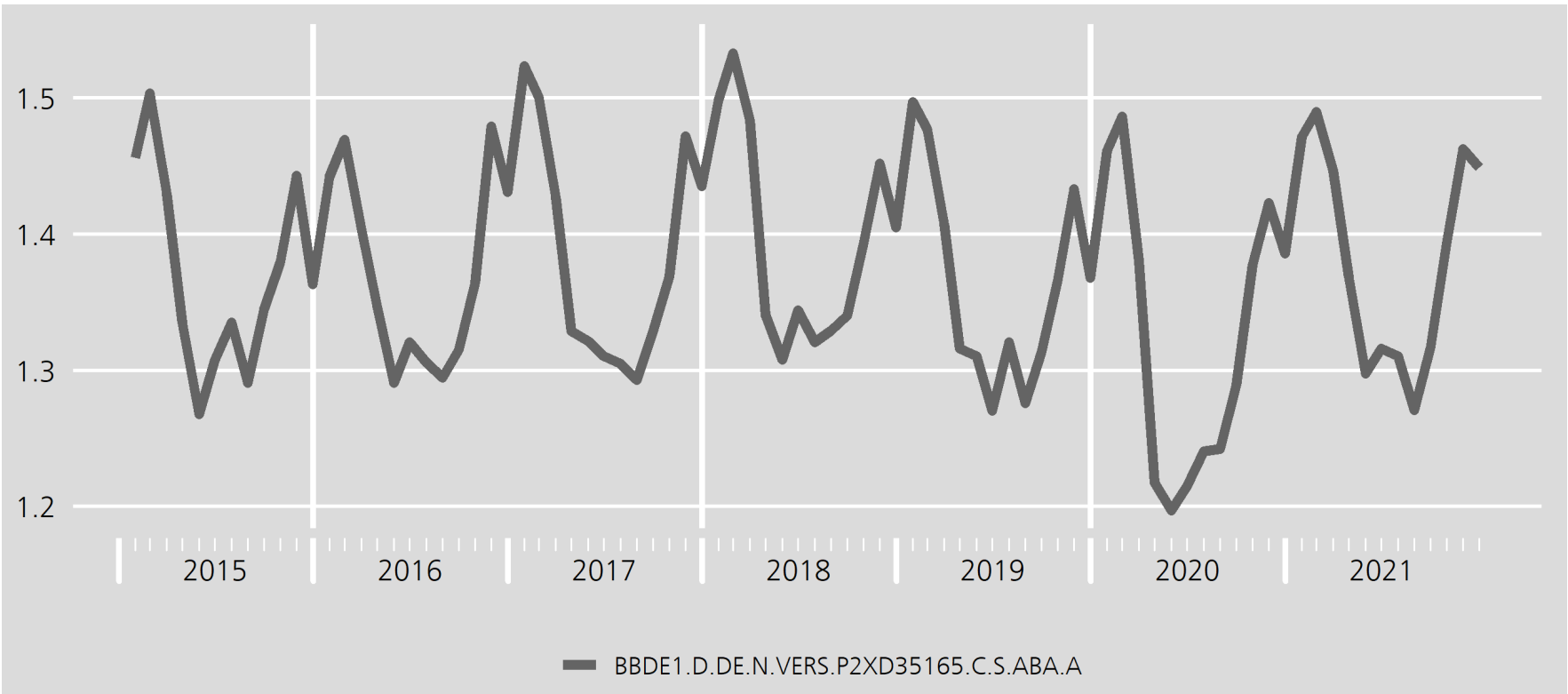
Name	Variable checked for significance	Short
Modified QS test	Autocorrelations at seasonal lags	QS
Friedman test	ANOVA with repeated measures on intra-year ranks	Fried
Kruskal-Wallis test	ANOVA without repeated measures on overall ranks	KW
Test for spectral peaks	Tukey and AR(30) spectra at seasonal 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" ARIMA model *	SD

* Variant 1: $(pdq) = (011)$, variant 2: (pdq) automatically identified.

Seasonality tests in JD+ (II/V)
Modified QS-test

Monthly electricity consumption in Germany

TW/h

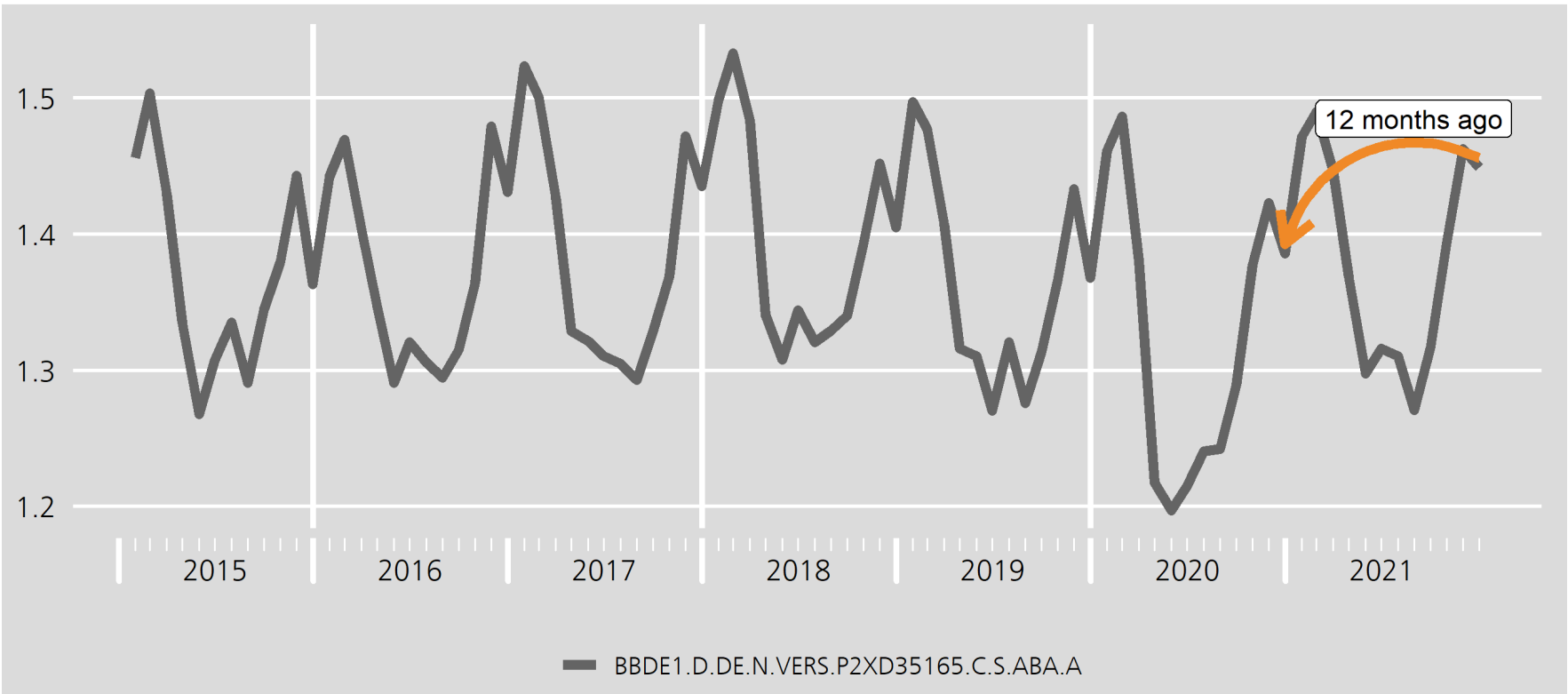


Source: Federal Network Agency
Deutsche Bundesbank

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

Monthly electricity consumption in Germany

TW/h



Source: Federal Network Agency
Deutsche Bundesbank

Seasonality tests in JD+ (IV/V)
Modified QS-test

$$QS = F\left[\hat{\rho}(y_t, y_{t-\tau}), \hat{\rho}(y_t, y_{t-2\tau})\right]$$

Null hypothesis

- No positive autocorrelation at seasonal lags (i.e. no seasonality)

Decision

- Rejection if *QS* too large

Seasonality tests in JD+ (V/V)
Friedman-test

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

Rank assignment

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

Null hypothesis

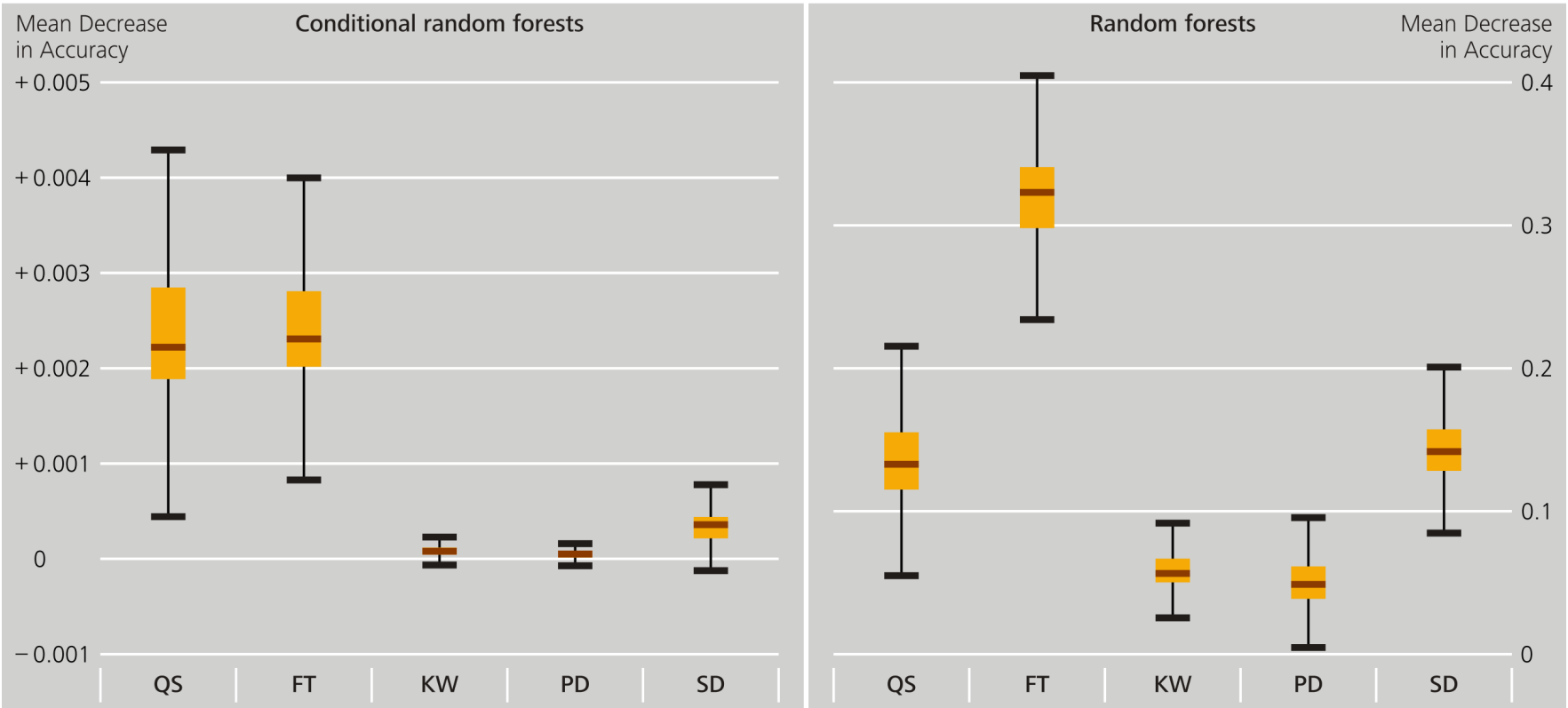
- Same month-specific mean ranks (i.e. no stable seasonality)

Decision

- Rejection if *FT*-statistics too large

Which seasonality test should we use?
Permutation-based variable importance, Ollech and Webel (2022)

Variable importance measures



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Additional F-tests (I/II)
Stable seasonality

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

Null hypothesis

- Same month-specific averages in trend-adjusted series (i.e. no stable seasonality)

Decision

- Rejection if F_S too large

Additional F-tests (II/II)
Moving seasonality

$$F_M = \frac{\text{Inter-year variance}}{\text{Residual variance}}$$

Null hypothesis

- Absence of annual effects in trend-adjusted series (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

- Limited Relevance

Heuristics (II/III)

M-statistics: $M7$

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

Interpretation

- Does moving seasonality dominate stable seasonality? $\rightsquigarrow$ Non-identifiable seasonality

Heuristics for X-11 approach (III/III)
Q-statistic

M-statistic	Weight as a percentage	M-statistic	Weight as a percentage
$M1$	13	$M7$	16
$M2$	13	$M8$	7
$M3$	10	$M9$	7
$M4$	5	$M10$	4
$M5$	11	$M11$	4
$M6$	10		

$M8$ to $M11$ are not calculated for series shorter than six years and, hence, other weights apply.

Summary

- Seasonality tests: QS and Friedman
- ACF and PACF helpful for ARIMA model
- Look at data

References: Methodology

- Ollech and Webel (2018). An overall seasonality test based on recursive feature elimination in conditional random forests. In: Proceedings of the 5th International Conference on Time Series and Forecasting, 20–31.
- Ollech and Webel (2022). A Random Forest-based Approach to Combining and Ranking Seasonality Tests. Journal of Econometric Methods.