Seasonal Adjustment: Ways to remove season



For relevant interpretation of time series

- Compare with the same period (quarter or month) last year
- **Use a simple moving average (MA)**
- Use seasonal adjustment (SA)
 ¥ Yields alternative series with seasonal variation removed



Seasonal Adjustment: Basic decomposition of a series



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Trend + Cycle	TC	Keep
+ Season effect	S	Remove
+ Calendar effect	<i>C</i>	Remove
+ Outliers	0	Keep
+ Irregular	Ι	Keep
= Observed series	Y	



Seasonal Adjustment: Additive vs multiplicative model



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Additive model: $Y_t = TC_t + S_t + C_t + O_t + I_t$ Seasonally adjusted and calendar corrected series (for additive model): $SAC_t = Y_t - S_t - C_t$ > Multiplicative model: $Y_t = TC_t \times S_t \times C_t \times O_t \times I_t$ Suits most economic series of positive numbers



Seasonal Adjustment: Spectral view 1

Spectral resolution of time series:

$$X_{t} = a + \int_{0}^{1/2} f(v) \sin(2\pi t v + \varphi(v)) dv + \varepsilon_{t}$$

where
$$v = frequencyin cycles per$$

month or quarter
 $f = spectral density$
($\varphi = phase shift, a is const., \varepsilon random)$



Seasonal Adjustment: Spectral view 2



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$X_t =$	$= a + \int_{0}^{1/2} f(v) \sin(2\pi t v + \varphi(v)) dv + \varepsilon_t$
	MA filters in general multiply spectral density f by a function (and change φ)
	A filter may kill frequencies, so that spectral density is 0 there after the filter
	An SA filter kills frequencies v that are "seasonal" (= an integer in number of cycles per year)

Seasonal Adjustment: Example of "gain function"



From: W.R. Bell & B.C. Monsell (1992), X-11 Symmetric linear filters and their transfer functions, Bureau of the Census

M. Ribe, SCB, 2010-03-10

Seasonal Adjustment: Main computation principles in SA

- Separate *TC*, *S* and *I* from each other
 by filters in principle weighted MAs,
 performed by software in a few steps
 - But before main filtering, remove calendar effects and outliers by regression analysis. Needed as filtering is not robust
- **Extrapolate components up to present time by ARIMA model**
- After filtering and extrapolating, put the outliers back onto the series

Seasonal Adjustment: Method and software alternatives



X-12-ARIMA from US Census Bureau

 Uses season extracting and smoothing
 (Henderson) filters in a short iterative
 sequence + ARIMA model for
 extrapolation



Tramo-Seats from Bank of Spain
– Uses ARIMA model for both trendcycle identification and extrapolation,
extracts season in frequency domain

Seasonal Adjustment: ARIMA model for extrapolation



- ➢ Filters are "centered" to be unbiased ⇒ filtered series is cut before the end
- But most recent time is most interesting
- > Thus extrapolate by ARIMA model:

$\Phi(B)X_t = \Theta(B) a_t$

with $\Phi(B)$, $\Theta(B)$ polynomials in backshift operator *B*, and a_t iid N(0,1)

Seasonal Adjustment: Two critical issues in SA



 Identify outliers
 Based on significance test, choice of risk level crucial

On both points judgment is needed and may strongly influence results

Seasonal Adjustment: Model types of outlier effects



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Seasonal Adjustment: Standardisation topics



- > Outliers, calendar effects
- Model updating
- Consistency between series
- Communication to users
- Software and methodology



Seasonal Adjustment: Communication to users



- > Assessment of quality of SA?
- > Matching users' own SA?
- > Criteria for suppression?
- > Explanation of meaning?
- Awareness of limitations SA not for early warning on turns etc.



Seasonal Adjustment: Ways to Summation Consistency



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i. "Indirect" seasonal adjustment **Cause reconciliation** ii. Simplemented in LFS iii. Result reconciliation Simplemented in NA iv. Multivariate approach

