Flexibilisation of X-11 for higher-frequency data

Lea Hengen, Nina Gonschorreck

Agenda

Motivation

Motivation

Higher-frequency data

- Weekly
- Daily

→ Seasonal adjustment with official methods not possible

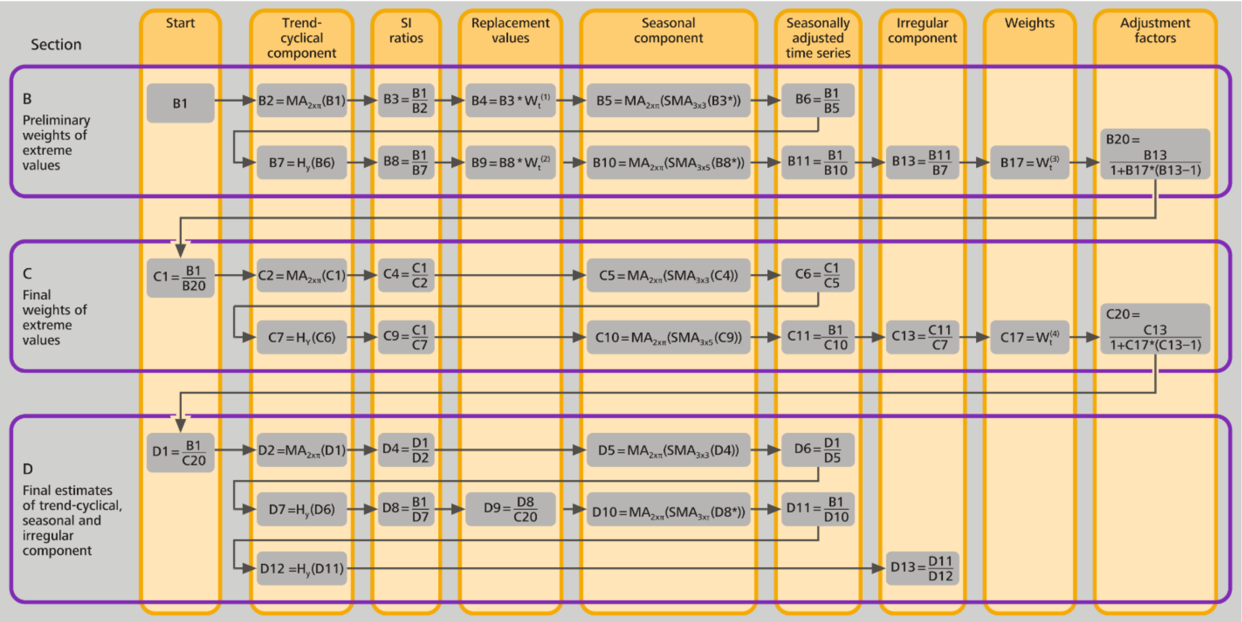
X-11

- Method for seasonal adjustment
- Identifies unobservable components
- Filter-based approach

X-11 method

The automatic X-11 routine in JDemetra+ for a multiplicative time series model

Workflow diagram



H_y(.): Henderson moving average of length y, with y determined based on I/C ratio or specified by user. $MA_{2x\pi}$: Moving average of length $2 x \pi$, with π = frequency of the series. $SMA_{3x\tau}$: Moving average, applied on a period-by-period basis, of length $3 x \tau$ with τ set determined based on I/S ratio or spezified by user. In the latter case the chosen SMA is *always used*. $W_t^{(\cdot)}$: Weights obtained based on moving standard deviation of irregular component.

Deutsche Bundesbank

S3IN0530.Chart

Flexible Henderson filter

Henderson filter length

Default length γ

Based on $\bar{I}/\bar{C}$-ratio with

$$\bar{I} = \frac{1}{n-1}\sum_{t=2}^{n} \text{abs}\left(\frac{I_t - I_{t-1}}{I_{t-1}}\right)$$

and

$$\bar{C} = \frac{1}{n-1}\sum_{t=2}^{n} \text{abs}\left(\frac{C_t - C_{t-1}}{C_{t-1}}\right)$$

$$\gamma = \begin{cases} 9\,, \bar{I}/\bar{C} < 1 \\ 23\,, \bar{I}/\bar{C} > 3.5 \\ 13\,, else \end{cases}$$

Length γ for higher frequencies

9 → frequency * ¾

13 → frequency + 1

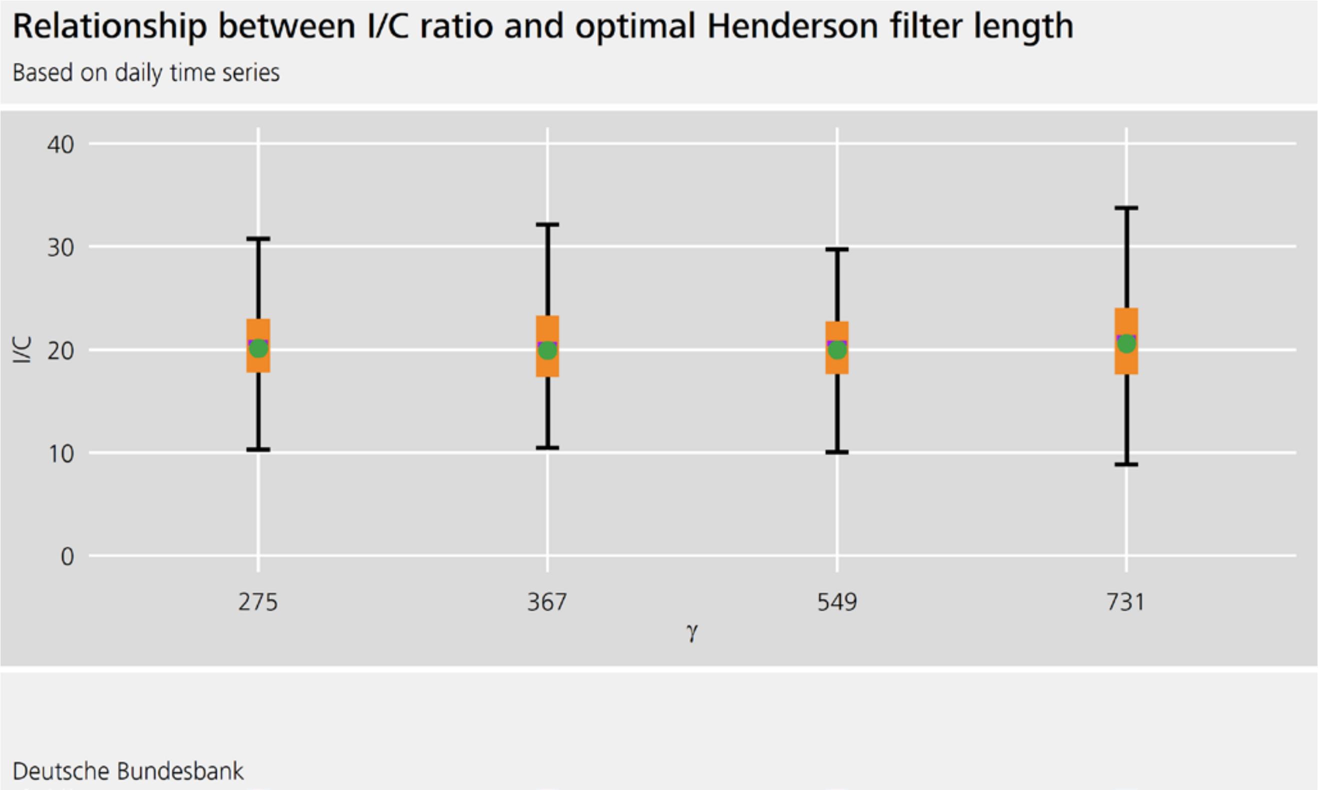
23 → frequency * 2 - 1

Are the default values suited for daily data?

e.g.

$$\gamma = \begin{cases} 275\,, \bar{I}/\bar{C} < 1 \\ 731\,, \bar{I}/\bar{C} > 3.5 \\ 367\,, else \end{cases}$$

Optimal filter length

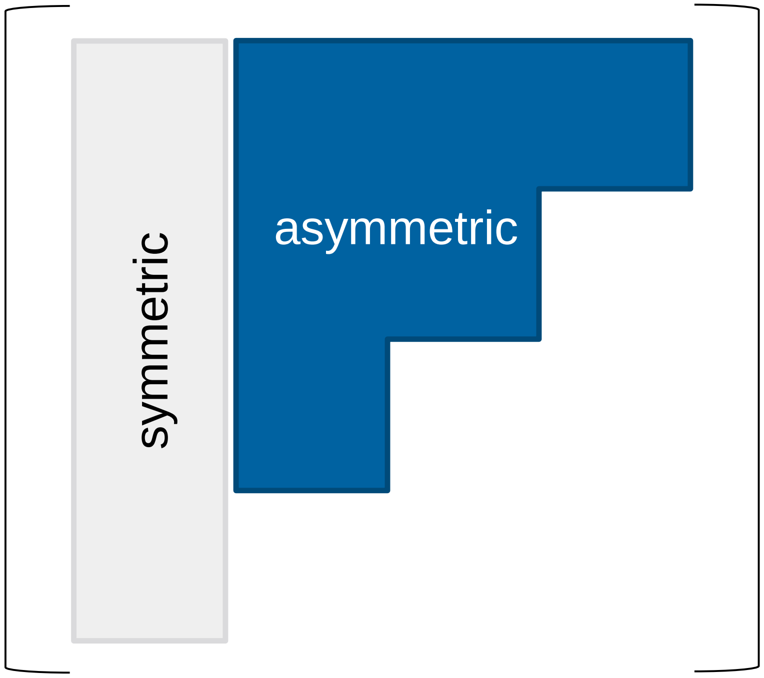


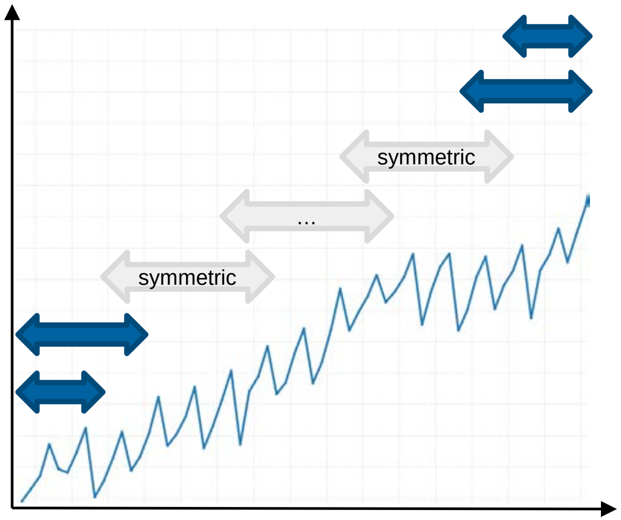
Flexible seasonal filters

Motivation

- Longest seasonal filter: S3x15
- For day-of-the-week: Corresponds to just 19 weeks

Structure of seasonal filters





Calculation of seasonal filter weigths

Symmetric seasonal filter

- S3x**Z** with $v = \frac{1}{3\boldsymbol{Z}}$

$$(v, 2 * v, 3 * v, \dots, 3 * v, 2 * v, v)^T$$

Asymmetric seasonal filter

- Weights are approximated by

$$v_j =$$

$$w_j + \frac{1}{M} \sum_{i=M+1}^{N} w_i + \frac{(j - \frac{M+1}{2} D)}{1 + \frac{M\,(M-1)(M+1)}{12} D} \sum_{i=M+1}^{N} (i - \frac{M+1}{2}) w_i$$

with D = 9.8

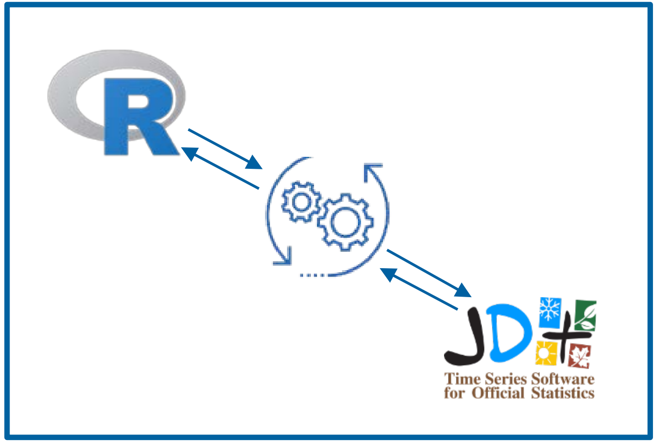
Ladiray, Quenville (2001). Seasonal Adjustment with the X11 Method. Springer. (p. 40,45)

Deriving S3x65

i	S33_33	S33_32	S33_31	⋯	S33_2	S33_1	S33_0
-33	0.005128205	0.004972806	0.005025916	⋯	0.00925370	0.009528174	0.009819289
-32	0.010256410	0.010108183	0.010216139	⋯	0.01880992	0.019367844	0.019959591
-31	0.015384615	0.015243561	0.015406363	⋯	0.02836614	0.029207513	0.030099893
-30	0.015384615	0.015250733	0.015413612	⋯	0.02837949	0.029221256	0.030114056
-29	0.015384615	0.015257905	0.015420861	⋯	0.02839284	0.029234998	0.030128218
-28	0.015384615	0.015265078	0.015428110	⋯	0.02840618	0.029248741	0.030142380
-27	0.015384615	0.015272250	0.015435359	⋯	0.02841953	0.029262483	0.030156543
⋮	⋮	⋮	⋮	⋯	⋮	⋮	⋮
-5	0.015384615	0.015430040	0.015594834	⋯	0.02871316	0.029564818	0.030468115
-4	0.015384615	0.015437212	0.015602083	⋯	0.02872650	0.029578561	0.030482277
-3	0.015384615	0.015444385	0.015609332	⋯	0.02873985	0.029592303	0.030496440
-2	0.015384615	0.015451557	0.015616581	⋯	0.02875320	0.029606046	0.030510602
-1	0.015384615	0.015458729	0.015623830	⋯	0.02876654	0.029619788	0.030524764
0	0.015384615	0.015465902	0.015631078	⋯	0.02877989	0.029633531	0.030538927
1	0.015384615	0.015473074	0.015638327	⋯	0.02879324	0.029647273	0
2	0.015384615	0.015480246	0.015645576	⋯	0.02880658	0	0
3	0.015384615	0.015487418	0.015652825	⋯	0	0	0
4	0.015384615	0.015494591	0.015660074	⋯	0	0	0
5	0.015384615	0.015501763	0.015667323	⋯	0	0	0
⋮	⋮	⋮	⋮	⋯	⋮	⋮	⋮
27	0.015384615	0.015659553	0.015826798	⋯	0	0	0
28	0.015384615	0.015666726	0.015834047	⋯	0	0	0
29	0.015384615	0.015673898	0.015841296	⋯	0	0	0
30	0.015384615	0.015681070	0.015848545	⋯	0	0	0
31	0.015384615	0.015688242	0.015855794	⋰	0	0	0
32	0.010256410	0.010567210	0	⋰	0	0	0
33	0.005128205	0	0	⋯	0	0	0

Prototype

Prototype



R-Package: X11DailyData

- Implemented in JDemetra+ version 3.0
- Wrapper in R

```
x11Experimental(
          timeseries,
          freq = 365,
          trendFilterLength = 367,
          seasonalFilter = "S3x65",
          decompositionMode = "Additive"
          )
```

- Available on GitHub.com/bbkrd

Presenters

Lea Hengen

Directorate General Statistics

Lea.Hengen@bundesbank.de
+49 69 9566 7577

Nina Gonschorreck

Directorate General Statistics

Nina.Gonschorreck@bundesbank.de
+49 69 9566 2258