Seasonality and trading days tests in JD+

ESTP training

12-14/10/2021

Overview

ummary

ata have been differenced and corrected for mean

Test	Seasonality
1. Auto-correlations at seasonal lags	YES
2. Friedman (non parametric)	YES
3. Kruskall-Wallis (non parametric)	YES
4. Spectral peaks	YES
5. Periodogram	YES
5bis. Max Periodogram	YES
6. Seasonal dummies	YES

asonality present

(12)=0.9146
(24)=0.8447

tribution: Chi2 with 2 degrees of freedom
lue: 384.9677
alue: 0.0000

Non parametric (Friedman) test

sed on the rank of the observations in each year

asonality present

tribution: Chi2 with 11 degrees of freedom
lue: 171.0598
alue: 0.0000

Non parametric (Kruskal-Wallis) test

sed on the rank of the observations

asonality present

tribution: Chi2 with 11 degrees of freedom
lue: 188.2961
alue: 0.0000

dentification of seasonal peaks in a Tukey periodogram and in an auto-regressive spectrum

asonality present

or t for Tukey periodogram, A or a for auto-regressive spectrum; 'T' or 'A' for very signficant peaks, 't' or 'a' for signficant peaks, '_' otherwise

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Periodogram

st on the sum of the values of a periodogram at seasonal frequencies

asonality present

tribution: F with 11 degrees of freedom in the nominator and 204 degrees of freedom in the denominator
lue: 261.0090
alue: 0.0000

Tests on regression with fixed seasonal dummies

gression model (on original series) with (0 1 1)(0 0 0) noises + mean

asonality present

tribution: F with 11 degrees of freedom in the nominator and 213 degrees of freedom in the denominator
lue: 226.1038

Seasonality tests

- Non parametric tests
  - Friedman
    - ANOVA-type. The test uses the rankings of the observations within each year. It does not require distributional assumptions.
    - H0: all periods can be treated equally (= no seasonality), H1: series is seasonal
    - P-value < 0.01 ⇒ H0 is rejected
    - Applied on series without trend (for instance (log) differenced series)
  - Kruskall-Wallis
    - The test uses the rankings of all the observations. It does not require distributional assumptions.
    - H0: All periods have the same mean(average ranking), H1: series is seasonal
    - Applied on series without trend (could work on any series)

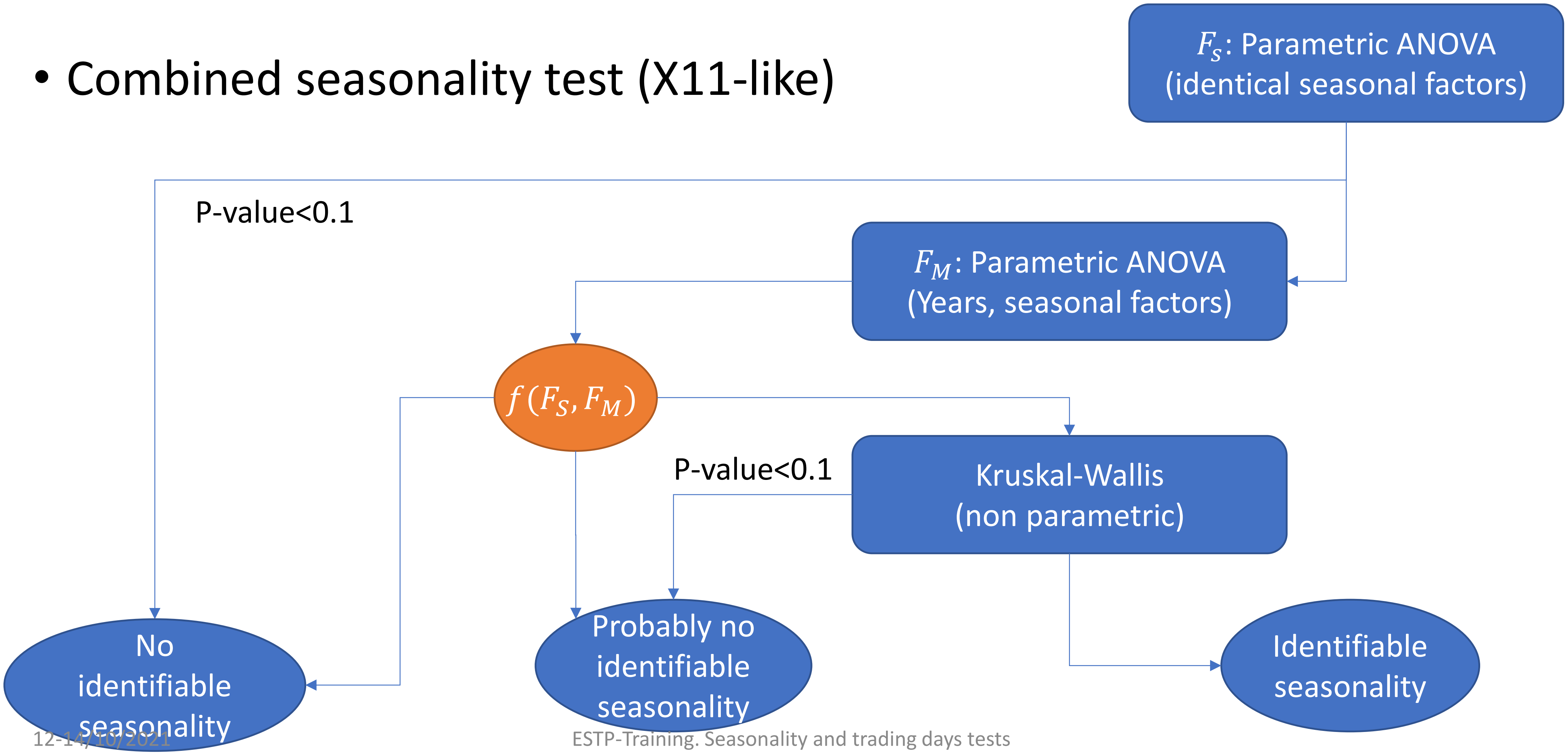
Seasonality tests (cont.)

- **QS test**
  - Ljung-box on seasonal auto-correlations
  - H0: No correlation (no seasonality), H1: seasonality
  - Applied on (log) differenced series (no trend), corrected for mean effect

- **F test** on seasonal dummies
  - Regression test with seasonal dummies ($D_{s,t}$) and different models
    - $y_t - y_{t-1} = D_{s,t}\beta + \varepsilon_t + \theta\varepsilon_{t-1}$ (GUI)
    - $y_t = \alpha + \gamma y_{t-1} + D_{s,t}\beta + \varepsilon_t$ (diagnostics)
    - $y_t - y_{t-1} = \alpha + D_{s,t}\beta + \varepsilon_t$ (diagnostics)
  - H0: coefficients (β) are equal to 0, H1: coefficients jointly differ from 0
  - Applied on (log) series. Should be applied on parts of the series

Seasonality tests (cont.)

- Combined seasonality test (X11-like)



Seasonality tests (cont.)

- Spectral diagnostics
  - Spectral peaks (X13-like)
    - Based on the spectrum of a long auto-regressive model that fits the series (see X13 documentation)
  - Periodogram
    - Performed on the periodogram (Fourier transformation) of the series at the Fourier frequencies.
      - <u>maximum</u> of the periodogram on or around the seasonal frequencies
      - <u>sum</u> of the values of the periodogram on or around the seasonal frequencies
    - Strictly speaking, only valid against the hypothesis that the (transformed) series is a white noise. As the spectral peaks, they don't perform well for short series.

Trading days tests

- **F test** on default trading days variables (contrasts)
  - Regression test with trading days contrasts (TD_t) and different models
    - $y_t = \alpha + \gamma y_{t-1} + TD_t\beta + \varepsilon_t$ (2.2.x)
    - $y_t - y_{t-1} = \alpha + TD_t\beta + \varepsilon_t$ (2.2.x)
    - $\Delta(y_t - TD_t\beta) = \alpha + \varepsilon_t$ (3.0)
    - $\Delta(y_t - TD_t\beta) = \varepsilon_t + \theta\varepsilon_{t-1}$ (3.0)
    - More generally: $y_t = \alpha + TD_t\beta + arima_t$
  - H0: coefficients (β) are equal to 0, H1: coefficients jointly differ from 0
  - Applied on (log) series. Should be applied on parts of the series

Tests in R

```
suppressPackageStartupMessages(library(rjd3sa))

s<-retail$RetailSalesTotal
ls<-log(s)
st<-do.stationary(ls, 12)
dls<-st$ddata

spec.pgram(dls)

spec.ar(dls)

print(seasonality.qs(dls, 12))

# H0: the series has no seasonality
# pvalue = prob[x>T]
# pvalue nearly 0 -> w reject H0

print(seasonality.kruskalwallis(dls, 12))

print(seasonality.friedman(dls, 12))
```

```
suppressPackageStartupMessages(library(rjd3tramoseats))

s<-retail$ShoeStores

sa<-fast.tramoseats(s, "rsafull")

ssa<-sa$decomposition$stochastics$sa$data

a<-sapply(8:20, function(j){rjd3sa::td.f(ssa, model = "D1", nyears = j)$pvalue})
b<-sapply(8:20, function(j){rjd3sa::td.f(ssa, model = "R011", nyears = j)$pvalue})
c<-sapply(8:20, function(j){rjd3sa::td.f(ssa, model = "R100", nyears = j)$pvalue})

matplot(cbind(a,b,c), pch=18)

sirr<-sa$decomposition$stochastics$i$data

a<-sapply(8:20, function(j){rjd3sa::td.f(sirr, model = "D1", nyears = j)$pvalue})
b<-sapply(8:20, function(j){rjd3sa::td.f(sirr, model = "WN", nyears = j)$pvalue})
c<-sapply(8:20, function(j){rjd3sa::td.f(sirr, model = "R100", nyears = j)$pvalue})

matplot(cbind(a,b,c), pch=18)
```