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RJDemetra: A R Interface To JDemetra+ Seasonal Adjustment Software

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Abstract

The abstract of the article.

Keywords: R, seasonal adjustment, time series.

1. Introduction

The package **RJDemetra** provides a R interface to the seasonal adjustment software JDemetra+. Note that, JDemetra+ being implemented in Java, **RJDemetra** relies on the **rJava** package and Java SE 8 or later version is required. The two leading seasonal adjustment methods TRAMO/SEATS+ and X-12ARIMA/X-13ARIMA-SEATS can be used with all the specifications defined in JDemetra+.

This article is structured as following.In the first section the .. is presented.

1.1. Seasonal adjustment in brief

The **first step** of seasonal adjustment, both in X-12ARIMA/X-13ARIMA-SEATS and TRAMO-SEATS+, consists of pre-adjusting the time series by removing from it the deterministic effects and estimating missing observations. Among deterministic effects, we distinguish outliers, calendar and regression effects. In this step, also forecasts and backcasts of the pre-adjusted series are estimated which allows applying linear filters at both ends of the series in the second step of the seasonal adjustment. The pre-adjustment, linearization, of the input series is achieved with a **RegARIMA** model (model with ARIMA errors) as specified below.

$$z_t = y_t\beta + x_t$$

where

- z_t - is the original series;
- $\beta = (\beta_1, ..., \beta_n)$ - a vector of regression coefficients;
- $y_t = (y_{1t}, ..., y_{nt})$ - n regression variables (outliers, calendar effects, user-defined variables);
- x_t - a disturbance that follows the general ARIMA process:
- $\phi(B)\delta(B)x_t = \theta(B)a_t$; $\phi(B), \delta(B)$ and $\theta(B)$ are the finite polynomials in B; a_t is a white-noise variable with zero mean and a constant variance.

The polynomial $\phi(B)$ is a stationary autoregressive (AR) polynomial in B, which is a product of the stationary regular AR polynomial in B and the stationary seasonal polynomial in B^s:

$$\phi(B) = \phi_p(B)\Phi_{bp}(B^s) = (1 + \phi_1 B + ... + \phi_p B^p)(1 + \Phi_1 B^s + ... + \Phi_{bp} B^{bps}$$

where:

- p - number of regular AR terms (in the package and in JDemetra+ $p \leq 3$);
- bp - number of seasonal AR terms (in the package and in JDemetra+ $bp \leq 1$);
- s - number of observations per year (frequency of the time series).

The polynomial $\theta(B)$ is an invertible moving average (MA) polynomial in B, which is a product of the invertible regular MA polynomial in B and the invertible seasonal MA polynomial in B^s:

$$\theta(B) = \theta_q(B)\Theta_{bq}(B^s) = (1 + \theta_1 B + ... + \theta_q B^q)(1 + \Theta_1 B^s + ... + \Theta_{bq} B^{bqs})$$

where:

- q - number of regular MA terms (in the package and in JDemetra+ $q \leq 3$);
- bq - number of seasonal MA terms (in the package and in JDemetra+ $bq \leq 1$);

The polynomial $\delta(B)$ is the non-stationary AR polynomial in B (unit roots):

$$\delta(B) = (1 - B)^d (1 - B^s)^{d_s}$$

where:

- d - regular differencing order (in the package and in JDemetra+ $d \leq 1$);
- d_s - seasonal differencing order (in the package and in JDemetra+ $d_s \leq 1$);

In the **second part** of seasonal adjustment, called the **decomposition**, the pre-adjusted series is decomposed into the following components: trend-cycle (`t`), seasonal component (`s`) and irregular component (`i`). The decomposition can be:

- additive (`y = t + s + i`)
- multiplicative (`y = t * s * i`)
- log-additive (`log(y) = log(t)+log(s)+log(i)`) or

- pseudo-additive (`y = t*(s+i-1)`)

The last two decompositions are available only under X13.

The method of decomposing the pre-adjusted series differs between TRAMO-SEATS+ and X-12ARIMA/X-13ARIMA. In TRAMO-SEATS+, SEATS ("Signal Extraction in ARIMA Time Series") decomposes the observed series with a ARIMA-model based method. Whereas in X-12ARIMA/X-13ARIMA, the X11 algorithm decomposes the time series by means of linear filters. More information on the TRAMO-SEATS+ method can be found on the Bank of Spain website (link) and on X-12ARIMA/X-13ARIMA, on the U.S. Census Bureau website.

As a result of seasonal adjustment, the final seasonally adjusted series (`sa`) shall be free of seasonal and calendar-related movements.

More details on the methodlogy used in JDemetra+ can be found in the JDemetra+ manuals and user guides available at link.

2. RJDemetra basics

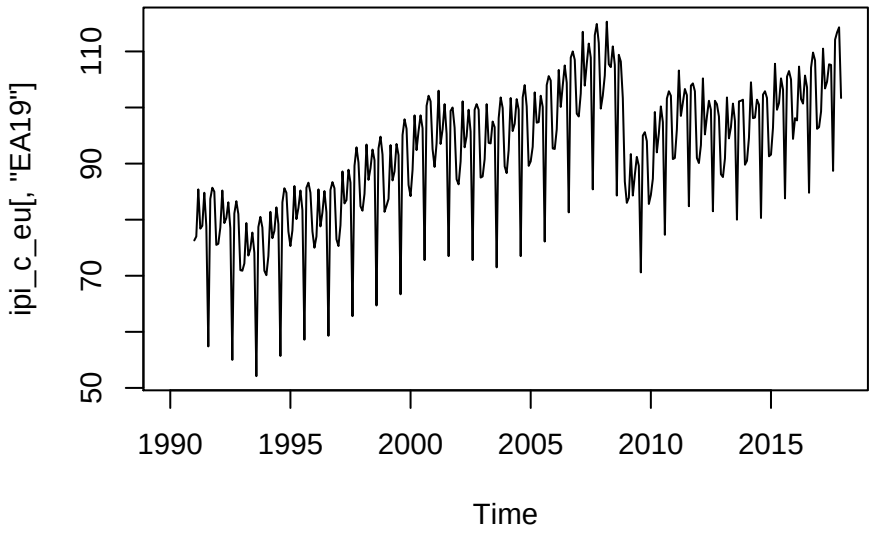
The **RJDemetra** package alows to:

- create and modify model specifications
- create and modify models
- import/export JDemetra+ workspaces

2.1. Dataset

In this package the sts_inpr_m database of Eurostat is included, which contains monthly industrial production indices in manufacturing in the European Union. It contains 37 time series from january 1990 to december 2017 which are considered to be affected by seasonal and working day effects. The data is a `ts` object and can be accessed using the `ipi_c_eu` object. The following snippet of code plots the industrial production index of the euro aera (EA19):

```
R> library(RJDemetra)
R> plot(ipi_c_eu[, "EA19"])
```



3. Estimate a pre-defined RegARIMA and SA model

As in JDemetra+, the **RJDemetra** package allows to perform seasonal adjustment using pre-defined model specifications. The specifications are separately defined for TRAMO-SEATS and X-13ARIMA-SEATS estimation methods. It is also possible to perform only the first step of seasonal adjustment; the RegARIMA estimation. The pre-defined model specifications are described in tables 1 and 2. They are identical for pre-adjustment (column 1) and for seasonal adjustment (column 2). The pre-defined specifications correspond to most commonly used specifications and users are recommended to start their analysis with one of them. We will follow also this approach and later it will be presented how to modify model specifications, including the possibility to incorprate user-defined regressors (see section 5).

The below code presents how to perform an estimation, with pre-defined specifications, of:

- RegARIMA
  - X-13ARIMA method: `regarima_def_x13(series, spec = c("RG5c", "RG0", "RG1", "RG2c", "RG3","RG4c"))`
  - TRAMO-SEATS method: `regarima_def_tramoseats(series, spec = c("TRfull", "TR0","TR1", "TR2","TR3", "TR4","TR5"))`
- Seasonal adjustment
  - X-13ARIMA method: `x13_def(series, spec = c("RSA5c", "RSA0", "RSA1", "RSA2c", "RSA3","RSA4c"), userdefined = NULL)`
  - TRAMO-SEATS method: `tramoseats_def(series, spec = c("RSAfull", "RSA0", "RSA1", "RSA2", "RSA", "RSA4", "RSA5"), userdefined = NULL)`

Table 1: Pre-defined specification for TRAMO and TRAMO-SEATS

Specification								
TRAMO	TRAMO-SEATS	Transformation	Pre-adjustment for leap-year	Working days	Trading days	Easter effect	Outliers	ARIMA model
TR0	RSA0	no	no	no	no	no	no	(0,1,1)(0,1,1)
TR1	RSA1	test	no	no	no	no	test	(0,1,1)(0,1,1)
TR2	RSA2	test	no	test	no	test	test	(0,1,1)(0,1,1)
TR3	RSA3	test	no	no	no	no	test	AMI
TR4	RSA4	test	no	test	no	test	test	AMI
TR5	RSA5	test	no	no	yes	test (Standard)	test	AMI
TRfull (default)	RSAfull (default)	test	yes	no	test	test (Include Easter)	test	AMI

Table 2: Pre-defined specification for RegARIMA and X-13ARIMA-SEATS

Specification								
RegARIMA	X-13ARIMA-SEATS	Transformation	Pre-adjustment for leap-year	Working days	Trading days	Easter effect	Outliers	ARIMA model
RG0	X11	no	no	no	no	no	no	(0,1,1)(0,1,1)
RG1	RSA1	test	no	no	no	no	test	(0,1,1)(0,1,1)
RG2c	RSA2c	test	test	test	no	test	test	(0,1,1)(0,1,1)
RG3	RSA3	test	no	no	no	no	test	AMI
RG4c	RSA4c	test	test	test	no	test	test	AMI
RG5c (default)	RSA5 (default)	test	test	no	test	test	test	AMI

```
R> library(RJDemetra)
R> myseries <- ipi_c_eu[, "EA19"]
R>
R> regx13 <- regarima_def_x13(myseries, spec = "RG5c")
R> regts <- regarima_def_tramoseats(myseries, spec = "TRfull")
R> sax13 <- x13_def(myseries, spec = "RSA5c", userdefined = NULL)
R> sats <- tramoseats_def(myseries, spec = "RSAfull", userdefined = NULL)
```

4. SA object structure

In the previous section it was presented how to run a RegARIMA and complete seasonal adjustment estimation with pre-defined model specifications. Here the outcome will be described in detail.

As a result of seasonal adjustment estimation (e.g. function `x13_def` or `tramoseats_def`) a S3 class object (`sa_object`) is created. It has a class `c("SA","X13")` or `c("SA","TRAMO_SEATS")` depending on the used estimation method. The `sa_object` consits of lists of S3 class sub-objects. For each of the class `print, plot` methods are defined. The complete structure of the `sa_object` is presented in table 3.

Table 3: SA object structure

			When adjusted with:	
			x13/x13_def	*tramoseats/tramoseats_def*
Object	Level	Type	Class	Class
sa_object	0	list	SA, X13	SA, TRAMO_SEATS
regarima	**1**	**list**	**regarima, X13**	**regarima, TRAMO_SEATS**
specification	2	list		
estimate	3	data.frame		
transform	3	data.frame		
regression	3	list		
userdef	4	list		
specification	5	data.frame		
outliers	5	data.frame or NA(empty)		
variables	5	list		
series	6	mts, ts, matrix or NA(empty)		
description	6	data.frame or NA(empty)		
trading.days	4	data.frame		
easter	4	data.frame		
outliers	3	data.frame		
arima	3	list		
specification	4	data.frame		
coefficients	4	data.frame or NA(empty)		
forecast	3	data.frame		
span	3	data.frame		
arma	2	vector - numeric		
arima.coefficients	2	matrix		
regression.coefficients	2	matrix		
loglik	2	matrix		
model	2	list		
spec_rslt	3	data.frame		
effects	3	mts, ts, matrix		
residuals	2	ts		
residuals.stat	2	list		
st.error	3	numeric		

tests	3	data.frame	regarima_rtests, data.frame	
forecast	2	mts, ts, matrix		
decomposition	**1**	**list**	**decomposition_X11**	
specification	2	data.frame	X11_spec, data.frame	
mode	2	character		
mstats	2	matrix		
si_ratio	2	mts, ts, matrix		
s_filter	2	vector - character		
t_filter	2	character		
decomposition	**1**	**list**		**decomposition_SEATS**
specification	2	data.frame	seats_spec, data.frame	
mode	2	character		
model	2	list		
model	3	matrix or empty list		
sa	3	matrix or empty list		
trend	3	matrix or empty list		
seasonal	3	matrix or empty list		
transitory	3	matrix or empty list		
irregular	3	matrix or empty list		
linearized	2	mts, ts, matrix		
components	2	mts, ts, matrix		
final	**1**	**list**	**final**	
series	2	mts, ts, matrix		
forecasts	2	mts, ts, matrix		
diagnostics	**1**	**list**	**diagnostics**	
variance_decomposition	2	data.frame		
combined_test	2	list	combined_test	
tests_for_stable_seasonality	3	data.frame		
combined_seasonality_test	3	character		
residuals_test	2	data.frame		
user_defined	**1**	**list**	**user_defined**	

4.1. Regarima

Here we can also present the output: print and graphs.

```
R> library(RJDemetra)
R> myseries <- ipi_c_eu[, "FR"]
R> mysa <- x13_def(myseries, spec=c("RSA5c"))
R> mysa$regarima

y = regression model + arima (0, 1, 1, 0, 1, 1)
Log-transformation: no
Coefficients:
          Estimate Std. Error
Theta(1)   -0.5270      0.048
BTheta(1)  -0.4865      0.051

              Estimate Std. Error
Monday       -0.133839      0.164
Tuesday      -0.002384      0.163
Wednesday     0.241712      0.163
Thursday     -0.531275      0.163
Friday        0.432474      0.164
```

```
Saturday      0.152956      0.163
Leap year    -0.045977      0.501
Easter [1]   -1.094082      0.335
LS (11-2008) -8.441602      1.307
LS (1-2009)  -7.274012      1.306
LS (5-2008)  -5.020079      1.257


Residual standard error: 1.665 on 323 degrees of freedom
Log likelihood = -624.7, aic =  1277 aicc =  1279, bic(corrected for length) = 1.252
```

4.2. Decomposition

4.3. Final

4.4. Diagnostics

4.5. user defined

5. Model specification: creation and modification

5.1. X13

5.2. TRAMOSEATS

5.3. Regarima

5.4. Wrong specifications corrections

Parler des corrections automatiques ?

6. Manipulate JDemetra+ workspaces

Mise en garde sur ce que l'on ne peut pas faire (problèmes d'imports)

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