

# Package ‘TimeSeries.OBeu’

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**Type** Package

**Title** Time Series Analysis 'OpenBudgets.eu'

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**Description** Estimate and return the needed parameters for visualizations designed for 'OpenBudgets.eu' <<http://openbudgets.eu/>> time series data. Calculate time series model and forecast parameters in budget time series data of municipalities across Europe, according to the 'OpenBudgets.eu' data model. There are functions for measuring deterministic and stochastic trend of the input time series data with 'ACF', 'PACF', 'Phillips Perron' test, 'Augmented Dickey Fuller (ADF)' test, 'Kwiatkowski-Phillips-Schmidt-Shin (KPSS)' test, 'Mann Kendall' test for monotonic trend and 'Cox and Stuart' trend test, decomposing with local regression models or 'stl' decomposition, fitting the appropriate 'arima' model and provide forecasts for the input 'OpenBudgets.eu' time series fiscal data. Also, can be used generally to extract visualization parameters convert them to 'JSON' format and use them as input in a different graphical interface.

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**URL** <https://github.com/okgreece/TimeSeries.OBeu>

**BugReports** <https://github.com/okgreece/TimeSeries.OBeu/issues>

**License** GPL-2 | file LICENSE

**LazyData** TRUE

**Encoding** UTF-8

**Imports** devtools, forecast, locfit, jsonlite, stats, trend, tseries

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**VignetteBuilder** knitr

**NeedsCompilation** no

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Athens_approved_ts	<i>Time series of Approved Expenditure Budget Phase of Municipality of Athens</i>
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**Description**

Time series data with the Approved Budget phase expenditure amounts of Municipality of Athens from 2004-2015

- The years of the recorded approved budget phase amounts
- The approved budget phase amounts of this time range

**Format**

A ts object with 12 approved amounts from 2004-2015

**Source**

The ttl and rdf expenditure data are stored in: <https://github.com/openbudgets/datasets/tree/master/greek-municipalities/municipality-of-athens/dataset>

---

Athens_draft_ts	<i>Time series of Draft Expenditure Budget Phase of Municipality of Athens</i>
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**Description**

Time series data with the Draft Budget phase expenditure amounts of Municipality of Athens from 2004-2015

- The years of the recorded draft budget phase amounts.
- The draft budget phase amounts of this time range.

**Format**

A ts object with 12 draft amounts from 2004-2015

**Source**

The ttl and rdf expenditure data are stored in: <https://github.com/openbudgets/datasets/tree/master/greek-municipalities/municipality-of-athens/dataset>

---

Athens_executed_ts	<i>Time series of Executed Expenditure Budget Phase of Municipality of Athens</i>
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**Description**

Time series data with the Executed Budget phase expenditure amounts of Municipality of Athens from 2004-2015

- The years of the recorded executed budget phase amounts.
- The executed budget phase amounts of this time range.

**Format**

A ts object with 12 draft amounts from 2004-2015

**Source**

The ttl and rdf expenditure data are stored in: <https://github.com/openbudgets/datasets/tree/master/greek-municipalities/municipality-of-athens/dataset>

---

Athens_reserved_ts	<i>Time series of Reserved Expenditure Budget Phase of Municipality of Athens</i>
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**Description**

Time series data with the Reserved Budget phase expenditure amounts of Municipality of Athens from 2004-2015

- The years of the recorded reserved budget phase amounts.
- The reserved budget phase amounts of this time range.

**Format**

A ts object with 12 reserved amounts from 2004-2015

**Source**

The ttl and rdf expenditure data are stored in: <https://github.com/openbudgets/datasets/tree/master/greek-municipalities/municipality-of-athens/dataset>

---

Athens_revised_ts	<i>Time series of Revised Expenditure Budget Phase of Municipality of Athens</i>
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---

**Description**

Time series data with the Revised Budget phase expenditure amounts of Municipality of Athens from 2004-2015

- The years of the recorded revised budget phase amounts.
- The revised budget phase amounts of this time range.

**Format**

A ts object with 12 revised amounts from 2004-2015

**Source**

The ttl and rdf expenditure data are stored in: <https://github.com/openbudgets/datasets/tree/master/greek-municipalities/municipality-of-athens/dataset>

---

open_spending.ts	<i>Read and analyze univariate time series data from Open Spending API</i>
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### Description

Extract and analyze univariate time series data from Open Spending API, using the `ts.analysis` function.

### Usage

```
open_spending.ts(json_data, time, amount,  
order = NULL, prediction_steps = 1)
```

### Arguments

<code>json_data</code>	The json string, URL or file from Open Spending API
<code>time</code>	Specify the time label of the json time series data
<code>amount</code>	Specify the amount label of the json time series data
<code>order</code>	An integer vector of length 3 specifying the order of the Arima model
<code>prediction_steps</code>	The number of prediction steps

### Details

This function extracts the time series data provided by the Open Spending API, in order to return the results from the `ts.analysis` function.

### Value

A json string with the resulted parameters of the `ts.analysis` function.

### Author(s)

Kleanthis Koupidis

### See Also

[ts.analysis](#)

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ts.acf	<i>Extract the ACF and PACF parameters of time series and their model residuals</i>
--------	---

---

### Description

This function is included in ts.analysis function and aims to extract the ACF and PACF details of the input time series data and the ACF, PACF of the residuals after fitting an Arima model.

### Usage

```
ts.acf(tsdata, model_residuals, a = 0.95, tojson = FALSE)
```

### Arguments

tsdata	The input univariate time series data
model_residuals	The model's residuals after fitting a model to the time series
a	The significant level (default a=0.95)
tojson	If TRUE the results are returned in json format, default returns a list

### Details

This function is used internally in ts.analysis function and the output is a list with grouped ACF and PACF parameters of the input time series data, as well as the ACF and PACF parameters of the residuals needed for the graphical purposes in OBEU.

### Value

A list with the parameters:

- acf.parameters:
  - acf The estimated acf values of the input time series
  - acf.lag The lags at which the acf is estimated
  - confidence.interval.up The upper limit of the confidence interval
  - confidence.interval.low The lower limit of the confidence interval
- pacf.parameters:
  - pacf The estimated pacf values of the input time series
  - pacf.lag The lags at which the pacf is estimated
  - confidence.interval.up The upper limit of the confidence interval
  - confidence.interval.low The lower limit of the confidence interval
- acf.residuals.parameters:
  - acf.res The estimated acf values of the model residuals
  - acf.res.lag The lags at which the acf is estimated of the model residuals

- confidence.interval.up The upper limit of the confidence interval
- confidence.interval.low The lower limit of the confidence interval
- pacf.residuals.parameters:
  - pacf.res The estimated pacf values of the model residuals
  - pacf.res.lag The lags at which the pacf is estimated of the model residuals
  - confidence.interval.up The upper limit of the confidence interval
  - confidence.interval.low The lower limit of the confidence interval

**Author(s)**

Kleanthis Koupidis

**See Also**

[ts.analysis](#), [Acf](#), [Pacf](#)

**Examples**

```
ts.acf(Athens_draft_ts)
```

---

ts.analysis

*Time series analysis results for OBEU Time series*

---

**Description**

Univariate time series analysis for short and long time series data using the appropriate model.

**Usage**

```
ts.analysis(tsdata, x.order = NULL, prediction.steps = 1, tojson = TRUE)
```

**Arguments**

tsdata	The input univariate time series data
x.order	An integer vector of length 3 specifying the order of the Arima model
prediction.steps	The number of prediction steps
tojson	If TRUE the results are returned in json format, default returns a list

## Details

This function automatically tests for stationarity of the input time series data using `ts.stationary.test` function. Depending the nature of the time series data and the stationary tests there are four branches: a.)short and non seasonal, b.)short and seasonal, c.)long and non seasonal and d.)long and seasonal. For branches a and c `ts.non.seas.model` is used and for b and d `ts.seasonal.model` is used.

This function also decomposes both seasonal and non seasonal time series through `ts.non.seas.decomp` and `ts.seasonal.decomp` and forecasts h steps ahead the user selected(default h=1) using `ts.forecast`.

## Value

A json string with the parameters:

- acf.param
  - acf.parameters:
    - \* acf The estimated acf values of the input time series
    - \* acf.lag The lags at which the acf is estimated
    - \* confidence.interval.up The upper limit of the confidence interval
    - \* confidence.interval.low The lower limit of the confidence interval
  - pacf.parameters:
    - \* pacf The estimated pacf values of the input time series
    - \* pacf.lag The lags at which the pacf is estimated
    - \* confidence.interval.up The upper limit of the confidence interval
    - \* confidence.interval.low The lower limit of the confidence interval
  - acf.residuals.parameters:
    - \* acf.res The estimated acf values of the model residuals
    - \* acf.res.lag The lags at which the acf is estimated of the model residuals
    - \* confidence.interval.up The upper limit of the confidence interval
    - \* confidence.interval.low The lower limit of the confidence interval
  - pacf.residuals.parameters:
    - \* pacf.res The estimated pacf values of the model residuals
    - \* pacf.res.lag The lags at which the pacf is estimated of the model residuals
    - \* confidence.interval.up The upper limit of the confidence interval
    - \* confidence.interval.low The lower limit of the confidence interval
- param
  - stl.plot:
    - \* trend The estimated trend component
    - \* trend.ci.up The estimated up limit for trend component (for non seasonal time series)
    - \* trend.ci.low The estimated low limit for trend component (for non seasonal time series)
    - \* seasonal The estimated seasonal component
    - \* remainder The estimated remainder component
    - \* time The time of the series was sampled



- stl.general:
  - \* stl.degree The degree of fit
  - \* degfr The effective degrees of freedom for non seasonal time series
  - \* degfr.fitted The fitted degrees of freedom for non seasonal time series
  - \* fitted The model's fitted values
- residuals The residuals of the model (fitted innovations)
- compare:
  - \* arima.order The Arima order for seasonal time series
  - \* arima.coef A vector of AR, MA and regression coefficients
  - \* arima.coef.se The standard error of the coefficients
  - \* covariance.coef The matrix of the estimated variance of the coefficients
  - \* resid.variance The residuals variance
  - \* not.used.obs The number of not used observations for the fitting
  - \* used.obs The used observations for the fitting
  - \* loglik The maximized log-likelihood (of the differenced data), or the approximation to it used
  - \* aic The AIC value corresponding to the log-likelihood
  - \* bic The BIC value corresponding to the log-likelihood
  - \* gcv The generalized cross-validation statistic time series
  - \* aicc The second-order Akaike Information Criterion corresponding to the log-likelihood for seasonal time series
- forecasts
  - ts.model a string indicating the arima orders
  - data\_year The time that time series data were sampled
  - data The time series values
  - predict\_time The time that defined by the prediction\_steps parameter
  - predict\_values The predicted values that defined by the prediction\_steps parameter
  - up80 The upper limit of the 80% predicted confidence interval
  - low80 The lower limit of the 80% predicted confidence interval
  - up95 The upper limit of the 95% predicted confidence interval
  - low95 The lower limit of the 95% predicted confidence interval

### Author(s)

Kleanthis Koupidis, Charalampos Bratsas

### See Also

[ts.stationary.test](#), [ts.acf](#), [ts.seasonal.model](#), [ts.seasonal.decomp](#), [ts.non.seas.model](#), [ts.non.seas.decomp](#), [ts.forecast](#)

### Examples

```
ts.analysis(Athens_draft_ts, prediction.steps = 3, tojson = FALSE)
```

---

`ts.forecast`*Time series forecast results of OBEU Time Series*

---

**Description**

Univariate time series forecasts for short and long time series data using the appropriate model.

**Usage**

```
ts.forecast(ts_modelx, h = 1, tojson = FALSE)
```

**Arguments**

<code>ts_modelx</code>	The input univariate time series data
<code>h</code>	The number of prediction steps
<code>tojson</code>	If TRUE the results are returned in json format, default returns a list

**Details**

This function is used internally in `ts.analysis` and forecasts the model that fits the input data using the `auto.arima` function (see forecast package). The model selection depends on the results of some diagnostic tests (`acf`, `pacf`, `pp`, `adf` and `kpss`). For short time series the selected arima model is among various orders of the AR part using the first differences and the first order moving average component, with the lower AIC value.

**Value**

A list with the parameters:

- `ts.model` a string indicating the arima orders
- `data_year` The time that time series data were sampled
- `data` The time series values
- `predict_time` The time that defined by the `prediction_steps` parameter
- `predict_values` The predicted values that defined by the `prediction_steps` parameter
- `up80`: The upper limit of the 80% predicted confidence interval
- `low80`: The lower limit of the 80% predicted confidence interval
- `up95`: The upper limit of the 95% predicted confidence interval
- `low95`: The lower limit of the 95% predicted confidence interval

**Author(s)**

Kleanthis Koupidis, Charalampos Bratsas

**See Also**

[ts.analysis](#), [forecast](#)

**Examples**

```
Athens_draft <- ts.non.seas.model(Athens_draft_ts)
#Hold the model object of non seasonal modeling
draft <- Athens_draft$model.summary
ts.forecast(draft)
```

---

ts.non.seas.decomp      *Non seasonal decomposition*

---

**Description**

Decomposition of time series with no seasonal component using local regression models

**Usage**

```
ts.non.seas.decomp(tpdata, tojson = FALSE)
```

**Arguments**

tpdata	The input univariate non seasonal time series data
tojson	If TRUE the results are returned in json format, default returns a list

**Details**

For non-seasonal time series there is no seasonal component. Local regression and likelihood models (locfit package) are used in order to extract the trend and remainder components.

**Value**

A list with the following components:

- stl.plot:
  - trend The estimated trend component
  - trend.ci.up The estimated up limit for trend component
  - trend.ci.low The estimated low limit for trend component
  - seasonal The estimated seasonal component
  - remainder The estimated remainder component
  - time The time of the series was sampled
- stl.general:
  - stl.degree The degree of fit
  - degfr The effective degrees of freedom

- degfr.fitted The fitted degrees of freedom
- residuals\_fitted:
  - residuals The residuals of the model (fitted innovations)
  - fitted The model's fitted values
  - time the time of tsdata
  - line The y=0 line
- compare:
  - resid.variance The residuals variance
  - used.obs The used observations for the fitting
  - loglik The maximized log-likelihood (of the differenced data), or the approximation to it used
  - aic The AIC value corresponding to the log-likelihood
  - bic The BIC value corresponding to the log-likelihood
  - gcv The generalized cross-validation statistic

**Author(s)**

Kleanthis Koupidis

**See Also**

[ts.analysis](#), [locfit](#), [predict.locfit](#)

**Examples**

```
ts.non.seas.decomp(Athens_draft_ts)
```

---

ts.non.seas.model      *Model fit of non seasonal time series*

---

**Description**

Model fit of non seasonal time series

**Usage**

```
ts.non.seas.model(tsdata, x.ord = NULL, tojson = FALSE)
```

**Arguments**

tsdata	The input univariate non seasonal time series data
x.ord	An integer vector of length 3 specifying the order of the Arima model
tojson	If TRUE the results are returned in json format, default returns a list

**Details**

Model fit of non seasonal time series using arima models of non seasonal time series data. The model with the lowest AIC value is selected for forecasts.

**Value**

A list with the following components:

- model.summary:
  - ts\_model The summary model details returned as Arima object for internal use in ts.analysis function
- model:
  - ts\_model:
  - arima.order The Arima order
  - arima.coef A vector of AR, MA and regression coefficients
  - arima.coef.se The standard error of the coefficients
- residuals: The residuals of the model (fitted innovations)
- compare:
  - variance.coef The matrix of the estimated variance of the coefficients
  - resid.variance The MLE of the innovations variance
  - not.used.obs The number of not used observations for the fitting
  - used.obs the number of used observations for the fitting
  - loglik The maximized log-likelihood (of the differenced data), or the approximation to it used
  - aic The AIC value corresponding to the log-likelihood
  - bic The BIC value corresponding to the log-likelihood
  - aicc The second-order Akaike Information Criterion corresponding to the log-likelihood

**Author(s)**

Kleanthis Koupidis

**See Also**

[ts.analysis](#), [Arima](#)

**Examples**

```
ts.non.seas.model(Athens_draft_ts)
```

---

ts.seasonal.decomp	<i>Decomposition of seasonal time series</i>
--------------------	--

---

### Description

Decomposition of seasonal time series data using stlm from forecast package. This function is used internally in ts.analysis.

### Usage

```
ts.seasonal.decomp(tsdata, tojson = FALSE)
```

### Arguments

tsdata	The input univariate seasonal time series data
tojson	If TRUE the results are returned in json format, default returns a list

### Details

Decomposition of seasonal time series data through arima models is based on stlm from forecast package and returns a list with useful parameters for OBEU.

### Value

A list with the following components:

- stl.plot:
  - trend: The estimated trend component
  - seasonal: The estimated seasonal component
  - remainder: The estimated remainder component
  - time: The time of the series was sampled
- stl.general:
  - model.summary The summary object of the arima model to use in forecast if needed
  - stl.win: An integer vector of length 3 indicating the spans used for the "s", "t", and "l" smoothers
  - stl.degree: An integer vector of length 3 indicating the polynomial degrees for these smoothers
- residuals\_fitted:
  - residuals: The residuals of the model (fitted innovations)
  - fitted: The model's fitted values
  - time the time of tsdata
  - line The y=0 line
- compare:
  - arima.order: The Arima order

- arima.coef: A vector of AR, MA and regression coefficients
- arima.coef.se: The standard error of the coefficients
- covariance.coef: The matrix of the estimated variance of the coefficients
- resid.variance: The MLE of the innovations variance
- not.used.obs: The number of not used observations for the fitting
- used.obs: the number of used observations for the fitting
- loglik: The maximized log-likelihood (of the differenced data), or the approximation to it used
- aic: The AIC value corresponding to the log-likelihood
- bic: The BIC value corresponding to the log-likelihood
- aicc: The second-order Akaike Information Criterion corresponding to the log-likelihood

**Author(s)**

Kleanthis Koupidis

**See Also**

[ts.analysis](#), [stlm](#)

---

ts.seasonal.model      *Model fit of seasonal time series*

---

**Description**

Model fit of seasonal time series

**Usage**

```
ts.seasonal.model(tsdata, x.ord = NULL, tojson = FALSE)
```

**Arguments**

tsdata	The input univariate seasonal time series data
x.ord	An integer vector of length 3 specifying the order of the Arima model
tojson	If TRUE the results are returned in json format, default returns a list

**Details**

Model fit of seasonal time series using arima models of seasonal time series data. The model with the lowest AIC value is selected for forecasts.

**Value**

A list with the following components:

- model.summary:
  - ts\_model The summary model details returned as Arima object for internal use in ts.analysis function
- model:
  - ts\_model
  - arima.order The Arima order
  - arima.coef A vector of AR, MA and regression coefficients
  - arima.coef.se The standard error of the coefficients
- residuals\_fitted:
  - residuals The residuals of the model (fitted innovations)
  - fitted The model's fitted values
  - time the time of tsdata
  - line The y=0 line
- compare:
  - variance.coef The matrix of the estimated variance of the coefficients
  - resid.variance The MLE of the innovations variance
  - not.used.obs The number of not used observations for the fitting
  - used.obs the number of used observations for the fitting
  - loglik The maximized log-likelihood (of the differenced data), or the approximation to it used
  - aic The AIC value corresponding to the log-likelihood
  - bic The BIC value corresponding to the log-likelihood
  - aicc The second-order Akaike Information Criterion corresponding to the log-likelihood

**Author(s)**

Kleanthis Koupidis

**See Also**

[ts.analysis](#), [Arima](#)



---

ts.stationary.test	Stationarity testing
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---

**Description**

This functions tests the stationarity of the input time series data.

**Usage**

```
ts.stationary.test(tldata)
```

**Arguments**

tsdata            The input univariate time series data

**Details**

This function tests the deterministic and stochastic trend of the input time series data. This function uses ACF and PACF functions from forecast package, Phillips Perron test, Augmented Dickey Fuller (ADF) test, Kwiatkowski Phillips Schmidt Shin (KPSS) test, from tseries package and Mann Kendall test for Monotonic Trend Cox Stuart trend test from trend package.

Phillips Perron test tests the null hypothesis of whether a unit root is present in a time series sample, against a stationary alternative. The truncation lag parameter is set to  $\text{trunc}(4*(n/100)^{0.25})$ , where n the length of the in input time series data

Augmented Dickey Fuller (ADF) test, tests the null hypothesis of whether a unit root is present in a time series sample. The truncation lag parameter is set to  $\text{trunc}((n-1)^{1/3})$ , where n the length of the input time series data

Kwiatkowski Phillips Schmidt Shin (KPSS) test, tests a null hypothesis that an observable time series is stationary around a deterministic trend (i.e. trend stationary) against the alternative of a unit root. The truncation lag parameter is set to  $\text{trunc}(3*\sqrt{n}/13)$ , where n the length of the input time series data

The non parametric Mann Kendall test is used to detect monotonic trends. The null hypothesis, H0, is that the data come from a population with independent realizations and are identically distributed. The alternative hypothesis, HA, is that the data follow a monotonic trend.

The Cox Stuart test is a modified sign test. The null hypothesis, H0, is that the input time series assumed to be independent against the fact that there is a time dependent trend (monotonic trend).

**Value**

A string indicating if the time series is stationary or non stationary for internal use in ts.analysis.

**Author(s)**

Kleanthis Koupidis, Charalampos Bratsas

**References**

tseries, trend

**See Also**

[ts.analysis](#), [Acf](#), [Pacf](#), [pp.test](#), [adf.test](#), [kpss.test](#), [mk.test](#), [cs.test](#)

**Examples**

```
ts.stationary.test(Athens_approved_ts)
```

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