

# Package ‘TSsmoothing’

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**Type** Package

**Title** Trend Estimation of Univariate and Bivariate Time Series with Controlled Smoothness

**Version** 0.1.0

**Description** It performs the smoothing approach provided by penalized least squares for univariate and bivariate time series, as proposed by Guerrero (2007) and Gerrero et al. (2017). This allows to estimate the time series trend by controlling the amount of resulting (joint) smoothness.

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Guerrero, V.M (2007) <[DOI:10.1016/j.spl.2007.03.006](https://doi.org/10.1016/j.spl.2007.03.006)>.

Guerrero, V.M; Islas-Camargo, A. and Ramirez-Ramirez, L.L. (2017) <[DOI:10.1080/03610926.2015.1133826](https://doi.org/10.1080/03610926.2015.1133826)>.

**Depends** R (>= 3.5.0)

**Imports** ggplot2(>= 3.2.0), MASS (>= 7.3.0), gridExtra (>= 2.3.0), Matrix (>= 1.2.0)

**License** GPL-3

**Encoding** UTF-8

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corrmvc	<i>Correlation from a 2d covariance matrix.</i>
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### Description

Computes the correlation given a covariance matrix of a bivariate variable.

### Usage

```
corrmvc(mat)
```

### Arguments

mat is a 2x2 covariace matrix

### Value

The empirical correlation fo the two series

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emp_agr	<i>Employment in agriculture</i>
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### Description

Dataset of the

### Usage

```
emp_agr
```

### Format

A ts vector a length of 25 observations from 1991 to 2015.

**Source**

<https://databank.worldbank.org/source/jobs#>

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graph\_trend

*Plot of original and smoothed time series.*

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**Description**

It plots the univariate or bivariate. This function is not intended for users but to be called by trend\_estimate.

**Usage**

```
graph_trend(dat, N, tau, dvar, label = NULL, jump = 1:N,  
            bands = TRUE, las, bivariate = TRUE)
```

**Arguments**

dat	is a 2x2 covariace matrix
N	the number of observations
tau	the smoothed time series
dvar	the estimated variance for tau
label	the vectors of characters associated to the time points to appear in the axis
jump	if label is too long, jump thin them on the axis
bands	is TRUE to draw the approximately 95% confidence bands around tau
las	is 1 and 2 if the asis should appear vertical and horizontal, respectively
bivariate	is FALSE if dat is a univariate time series

**Value**

The empirical correlation fo the two series

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lambda_value	<i>Calculation of the lambda value.</i>
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**Description**

Obtains the lambda value for specific values of the smoothing level, correlation and length.

**Usage**

```
lambda_value(s, rho, N)
```

**Arguments**

s	is a scalar that specifies the smoothing level.
rho	is the estimated correlation of the two time series. If the time series is univariate rho should be 0.
N	the length of the bivariate time series.

**Value**

The value of lambda lambda\_value that corresponds to a smoothing level s  
 A flag to indicate if the lambda value was read from ltable

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ltable	<i>Lambda values table.</i>
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**Description**

An array that presents the lambda values according to time series (N), the smoothing value (s), and the ts correlation (rho).

**Usage**

```
ltable
```

**Format**

A 3d array with dimension 393 x 12 x 11, where dimensions are:

**N** with values from 8 to 400

**s** with smoothing values c(0.5, 0.6, 0.7, 0.75, 0.8, 0.825, 0.85, 0.875, 0.9, 0.925, 0.95, 0.975)

**rho** with values c(0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 0.95)

**Details**

3d array of float number that correspond to the lambda values that correspond to the specified values of the length of the

**Source**

<http://www.diamondse.info/>

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plot_trend	<i>Plot fo the time series and its smoothed version in ggplo</i>
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**Description**

It plots the univariate or bivariate time series and its smoothed version (trend) using ggplot. It directly uses the output of trend\_estimate.

**Usage**

```
plot_trend(smoothedTS, title = NULL, xlab = "Time",
           ylab = names(dat)[1:2])
```

**Arguments**

smoothedTS	Is an object generated by the function trend_estimate
title	Main title of the graph
xlab	Common x label
ylab	A 2-length vector of characters.

**Value**

The ggplot of the original time series, their treind and its approximated 95

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positive_definite	<i>Checks if a squared matrix is positive definite and turn it to positive definied if necessary</i>
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**Description**

Checks if a squared matrix is positive definite and turn it to positive definied if necessary

**Usage**

```
positive_definite(m, c = NULL)
```

**Arguments**

m	Is a 2x2 matrix.
c	Is a small nonnegative number.

**Value**

The same matrix (if positive definite) or its modification that is positive definite.

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```
preliminar
```

```
Preliminar smoothing
```

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**Description**

Obtains the preliminar smoothed series, based on the preliminar lambda value and empirical estimates for Sigma\_eta and Sigma\_epsilon. This function is called by trend\_estimate as part of the smoothing process.

**Usage**

```
preliminar(dat)
```

**Arguments**

dat	is a 2-column matrix with the observations of a bivariate time series. Each row correspond to the values at a given time.
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**Value**

The preliminary smoothen series ptau.

The final estimate for sigma.eta

The time series correlation given by sigma.eta, rho.eta.

The preliminary estimation for sigma\_epsilon, sigma.epsilon,

A suggested value for lambda given by the empirical estimations.

The empirical time series correlation (preliminar to rho.eta), emp\_rho.

The time series length N.

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psigma\_estimates      *Preliminar estimates*

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**Description**

It computes the preliminary estimates of Sigma\_epsilon and Sigma\_eta

**Usage**

```
psigma_estimates(dat)
```

**Arguments**

dat                    is a 2 column matrix with for the bivariate time series observations. Each column correspond to the values at a given time.

**Value**

Sigma epsilon  
Sigma eta

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sigma\_zf              *Empirical cross-covarinace.*

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**Description**

Function that calculates the empirical cross-covariance of order h for a bivariate time series.

**Usage**

```
sigma_zf(h, vec1, vec2, N)
```

**Arguments**

h                      the lag value.  
vec1                   observations for the first variable of the bivariate time series.  
vec2                   observations for the second variable of the bivariate time series.  
N                      the common length of vec1 and vec2.

**Value**

The value of lambda that corresponds to a smoothing level s.

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smoothing_level	<i>Smoothing value</i>
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**Description**

Function that reports the smoothing level for a given value of lambda, N and rho (=0 if univariate).

**Usage**

```
smoothing_level(lambda, rho, N)
```

**Arguments**

lambda	a nonegative number.
rho	the correlation of the time series.
N	the length of the observations.

**Value**

S

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trade	<i>Annual Trade for USA and Mexico</i>
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**Description**

A dataset (matrix) containing the annual trade (

**Usage**

```
trade
```

**Format**

An object of class `matrix` with 49 rows and 2 columns.

**Source**

<https://databank.worldbank.org/source/world-development-indicators#>

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trend_estimate	<i>Trend estimation with controlled smoothing.</i>
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### Description

This is the main function that estimates the trend for univariate or bivariate time series for a specified smoothing level.

### Usage

```
trend_estimate(dat, smoothing_level = NULL, lambda = NULL,
              plot = TRUE, label = time(dat), jump = NULL, las = 2,
              bands = TRUE)
```

### Arguments

dat	is a 2x2 matrix with the two time series. Each column correspond to the values at a given time.
smoothing_level	is a scalar between 0 and 1 that specifies the smoothing of the resulting time series tau.
lambda	Alternative, the function directly accepts the lambda value that corresponds to the desired smoothing level.
plot	is TRUE when we want to plot of the original against the resulting series.
label	vector of characters that corresponds to the labels for each time point in the serie.
jump	is a vector of integers that specifies which values of labels should appear in the x labels.
las	is 1(2) if the x labels should be vertical (horizontal).
bands	is TRUE to include 95% confidence bands in the plots.

### Value

The smoothed series tau.

The original data dat.

The estimation for sigma\_eta, sigma.eta

The length of the time series N.

The lambda value corresponding to the smoothing level.

The diagonal values of the estimated variance of tau, diag.var.tau

A flag that indicates if data is a bivariate time series.

**Examples**

```
# Employment in agriculture (\% of total employment) (modeled ILO estimate) in OCDE members
data(empAgr) #It is a ts object with one single time series
sts<-trend_estimate(empAgr,0.70)
plot_trend(sts, title="Employment in agriculture in OCDE members", xlab = "Years")

# Data Trade (\% of GDP) for USA and Mexico downloaded from
data(trade) #It is a numeric matrix with two columns
sts<-trend_estimate(trade,0.7)
plot_trend(sts, title="Trade in% of GDP",xlab="years")

ts_trade<-ts(trade, start=1969,end=2017) #We transform trade to a ts object
sts<-trend_estimate(ts_trade,0.7)
plot_trend(sts, title="Trade in% of GDP",xlab="years")
```

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