

Package ‘matrisk’

May 8, 2026

Title Macroeconomic-at-Risk

Version 0.1.0

Description The Macroeconomics-at-Risk (MaR) approach is based on a two-step semi-parametric estimation procedure that allows to forecast the full conditional distribution of an economic variable at a given horizon, as a function of a set of factors. These density forecasts are then be used to produce coherent forecasts for any downside risk measure, e.g., value-at-risk, expected shortfall, downside entropy. Initially introduced by Adrian et al. (2019) <[doi:10.1257/aer.20161923](https://doi.org/10.1257/aer.20161923)> to reveal the vulnerability of economic growth to financial conditions, the MaR approach is currently extensively used by international financial institutions to provide Value-at-Risk (VaR) type forecasts for GDP growth (Growth-at-Risk) or inflation (Inflation-at-Risk). This package provides methods for estimating these models. Datasets for the US and the Eurozone are available to allow testing of the Adrian et al (2019) model. This package constitutes a useful toolbox (data and functions) for private practitioners, scholars as well as policymakers.

Depends R (>= 2.10)

License GPL-3

Encoding UTF-8

RoxygenNote 7.2.3

Imports stats, quantreg, sn, dfoptim, plot3D

NeedsCompilation no

Author Quentin Lajaunie [aut, cre],
Guillaume Flament [aut],
Christophe Hurlin [aut]

Maintainer Quentin Lajaunie <quentin_lajaunie@hotmail.fr>

Repository CRAN

Date/Publication 2023-05-02 08:30:05 UTC

Contents

| | |
|------------------------------|---|
| data_euro | 2 |
| data_US | 2 |
| f_compile_quantile | 3 |

| | |
|---------------------------|---|
| f_distrib | 4 |
| f_distrib_histo | 5 |
| f_ES | 7 |
| f_VaR | 8 |

| | |
|--------------|----------|
| Index | 9 |
|--------------|----------|

| | |
|-----------|--|
| data_euro | <i>Historical data for the eurozone (GDP and Financial Conditions) from 2008:Q4 to 2022:Q3</i> |
|-----------|--|

Description

data_euro contains: - Quarterly annualized GDP, from 2008:Q4 to 2022:Q3 - Financial Condition Index of the euro Area, from 2008:Q4 to 2022:Q3 - Composite Indicator of Systemic Stress, from 2008:Q4 to 2022:Q3 Sources : <https://sdw.ecb.europa.eu/browseExplanation.do?node=9689686> https://webstat.banque-france.fr/ws_wsen/browseSelection.do?node=DATASETS_FCI <https://fred.stlouisfed.org/series/CLVMEURSCAB1GQEA1>

Usage

```
data("data_euro")
```

Format

A data frame with 57 observations on the following 4 variables.

DATE Vector of dates.

GDP Vector of annualized PIB.

FCI Historical values of the Financial Condition Index (FCI).

CISS Historical values of the Composite Indicator of Systemic Stress (CISS).

| | |
|---------|--|
| data_US | <i>Historical data for the US (GDP and Financial Conditions) from 1973:Q1 to 2022:Q3</i> |
|---------|--|

Description

data_euro contains: - Quarterly annualized GDP, from 1973:Q1 to 2022:Q3 - National Financial Condition Index of the US, from 1973:Q1 to 2022:Q3 Sources : <https://www.chicagofed.org/research/data/nfci/current-data> <https://fred.stlouisfed.org/series/A191RL1Q225SBEA>

Usage

```
data("data_US")
```

Format

A data frame with 200 observations on the following 4 variables.

DATE Vector of dates.

GDP Vector of annualized PIB.

NFCI Historical values of the National Financial Condition Index (NFCI).

| | |
|--------------------|--------------------------------|
| f_compile_quantile | <i>Estimation of quantiles</i> |
|--------------------|--------------------------------|

Description

Predicted values based on each quantile regression (Koenker and Basset, 1978), at time=t_trgt, for each quantile in qt_trgt.

Usage

```
f_compile_quantile(qt_trgt, v_dep, v_expl, t_trgt)
```

Arguments

| | |
|---------|--|
| qt_trgt | Numeric vector, dim k, of k quantiles for different qt-estimations |
| v_dep | Numeric vector of the dependent variable |
| v_expl | Numeric vector of the (k) explanatory variable(s) |
| t_trgt | Numeric time target (optional) |

Value

Numeric matrix with the predicted values based on each quantile regression, at time fixed in input

References

Koenker, Roger, and Gilbert Bassett Jr. "Regression quantiles." *Econometrica: journal of the Econometric Society* (1978): 33-50.

Examples

```
# Import data
data("data_euro")

#' # Data process
PIB_euro_forward_4 = data_euro["GDP"][c(5:length(data_euro["GDP"][,1])),]
FCI_euro_lag_4 = data_euro["FCI"][c(1:(length(data_euro["GDP"][,1]) - 4)),]
CISS_euro_lag_4 = data_euro["CISS"][c(1:(length(data_euro["GDP"][,1]) - 4)),]

quantile_target <- as.vector(c(0.10,0.25,0.75,0.90))
results_quantile_reg <- f_compile_quantile(qt_trgt=quantile_target,
```

```
v_dep=PIB_euro_forward_4,
v_expl=cbind(FCI_euro_lag_4, CISS_euro_lag_4),
t_trgt = 30)
```

f_distrib

Distribution

Description

This function is used to estimate the parameters of the distribution (mean and standard deviation for Gaussian, xi, omega, alpha, and nu for skew-t) based on the quantile regression results (Koenker and Basset, 1978). See Adrian et al. (2019) and Adrian et al. (2022) for more details on the estimation steps.

Usage

```
f_distrib(type_function, compile_qt, starting_values)
```

Arguments

| | |
|-----------------|---|
| type_function | String argument : "gaussian" for normal distribution or "skew-t" for t-student distribution |
| compile_qt | Numeric matrix containing different quantiles and associated values |
| starting_values | Numeric vector with initial values for optimization |

Value

a data.frame with the parameters of the distribution

References

Adrian, Tobias, Nina Boyarchenko, and Domenico Giannone. "Vulnerable growth." *American Economic Review* 109.4 (2019): 1263-89.

Adrian, Tobias, et al. "The term structure of growth-at-risk. " *American Economic Journal: Macroeconomics* 14.3 (2022): 283-323.

Koenker, Roger, and Gilbert Bassett Jr. "Regression quantiles." *Econometrica: journal of the Econometric Society* (1978): 33-50.

Examples

```
# Import data
data("data_euro")

# Data process
PIB_euro_forward_4 = data_euro["GDP"][c(5:length(data_euro["GDP"][,1])),]
```

```
FCI_euro_lag_4 = data_euro["FCI"][c(1:(length(data_euro["GDP"][,1]) - 4)),]
CISS_euro_lag_4 = data_euro["CISS"][c(1:(length(data_euro["GDP"][,1]) - 4)),]

# for a gaussian
quantile_target <- as.vector(c(0.25,0.75))
results_quantile_reg <- f_compile_quantile(qt_trgt=quantile_target,
v_dep=PIB_euro_forward_4,
v_expl=cbind(FCI_euro_lag_4, CISS_euro_lag_4),
t_trgt = 30)

results_g <- f_distrib(type_function="gaussian",
compile_qt=results_quantile_reg,
starting_values=c(0, 1))

# for a skew-t
quantile_target <- as.vector(c(0.10,0.25,0.75,0.90))
results_quantile_reg <- f_compile_quantile(qt_trgt=quantile_target,
v_dep=PIB_euro_forward_4,
v_expl=cbind(FCI_euro_lag_4, CISS_euro_lag_4),
t_trgt = 30)

results_s <- f_distrib(type_function="skew-t",
compile_qt=results_quantile_reg,
starting_values=c(0, 1, -0.5, 1.3))
```

f_distrib_histo

Historical distributions

Description

This function is based on `f_distrib` function (Adrian et al., 2019; Adrian et al., 2022) and is used to get historical estimation of empirical distributions and associated parameters. Results allow to realize a 3D graphical representation.

Usage

```
f_distrib_histo(  
  qt_trgt,  
  v_dep,  
  v_expl,  
  type_function,  
  starting_values,  
  step,  
  x_min,  
  x_max  
)
```

Arguments

| | |
|------------------------------|---|
| <code>qt_trgt</code> | Numeric vector, dim k, of k quantiles for different qt-estimations |
| <code>v_dep</code> | Numeric vector of the dependent variable |
| <code>v_expl</code> | Numeric vector of the (k) explanatory variable(s) |
| <code>type_function</code> | String argument : "gaussian" for normal distribution or "skew-t" for t-student distribution |
| <code>starting_values</code> | Numeric vector with initial values for optimization |
| <code>step</code> | Numeric argument for accuracy graphics abscissa |
| <code>x_min</code> | Numeric optional argument (default value = -15) |
| <code>x_max</code> | Numeric optional argument (default value = 10) |

Value

A list with:

| | |
|----------------------------|--|
| <code>distrib_histo</code> | Numeric matrix with historical values of x, y and t |
| <code>param_histo</code> | Numeric matrix containing the parameters of the distribution for each period |

References

Adrian, Tobias, Nina Boyarchenko, and Domenico Giannone. "Vulnerable growth." *American Economic Review* 109.4 (2019): 1263-89.

Adrian, Tobias, et al. "The term structure of growth-at-risk." *American Economic Journal: Macroeconomics* 14.3 (2022): 283-323.

Examples

```
# Import data
data("data_euro")

# Data process
PIB_euro_forward_4 = data_euro["GDP"][c(5:length(data_euro["GDP"][,1])),]
FCI_euro_lag_4 = data_euro["FCI"][c(1:(length(data_euro["GDP"][,1]) - 4)),]
CISS_euro_lag_4 = data_euro["CISS"][c(1:(length(data_euro["GDP"][,1]) - 4)),]

results_histo <- f_distrib_histo(qt_trgt=c(0.10,0.25,0.75,0.90), v_dep=PIB_euro_forward_4,
v_expl=cbind(FCI_euro_lag_4,CISS_euro_lag_4),
type_function="skew-t",
starting_values=c(0, 1, -0.5, 1.3),
step=5, x_min=-10, x_max=5)

library(plot3D) # load
scatter3D(results_histo$distrib_histo[,3],
results_histo$distrib_histo[,1],
results_histo$distrib_histo[,2],
pch = 10, theta = 70, phi = 10,
main = "Distribution of GDP Growth over time - Euro Area",
```

```
xlab = "Date",
ylab = "Pib",
zlab="", cex = 0.3)
```

f_ES

*Expected Shortfall***Description**

The function allows to calculate Expected-shortfall for a given distribution. It takes as parameters alpha (risk level), a distribution and the parameters associated with this distribution. For example, for a normal distribution, the user must enter the mean and the standard deviation. Currently, the function can calculate the Expected-shortfall for the normal distribution and for the skew-t distribution (Azzalini and Capitanio, 2003)

Usage

```
f_ES(alpha, dist, params, accuracy = 1e-05)
```

Arguments

| | |
|----------|---|
| alpha | Numeric argument for Expected-Shortfall, between 0 and 1 |
| dist | String for the type of distribution (gaussian or skew-t) |
| params | Numeric vector containing parameters of the distribution |
| accuracy | Scalar value which regulates the accuracy of the ES (default value 1e-05) |

Value

Numeric value for the expected-shortfall given the distribution and the alpha risk

References

Azzalini, Adelchi, and Antonella Capitanio. "Distributions generated by perturbation of symmetry with emphasis on a multivariate skew t-distribution." *Journal of the Royal Statistical Society: Series B (Statistical Methodology)* 65.2 (2003): 367-389.

Azzalini, Adelchi, and Maintainer Adelchi Azzalini. "Package 'sn'." *The skew-normal and skew-t distributions* (2015): 1-3.

Examples

```
f_ES(0.95, "gaussian", params=c(0,1))
f_ES(0.95, "gaussian", params=c(0,1), accuracy=1e-05)
f_ES(0.95, "gaussian", params=c(0,1), accuracy=1e-04)
```

`f_VaR`*Value-at-Risk*

Description

The function allows to calculate Value-at-Risk for a given distribution. It takes as parameters alpha (risk level), a distribution and the parameters associated with this distribution. For example, for a normal distribution, the user must enter the mean and the standard deviation. Currently, the function can calculate the Value-at-Risk for the normal distribution and for the skew-t distribution (Azzalini and Capitanio, 2003)

Usage

```
f_VaR(alpha, dist, params)
```

Arguments

| | |
|---------------------|--|
| <code>alpha</code> | Numeric argument for Expected-Shortfall, between 0 and 1 |
| <code>dist</code> | String for the type of distribution (gaussian or skew-t) |
| <code>params</code> | Numeric vector containing parameters of the distribution |

Value

Numeric value for the Value-at-Risk given the distribution and the alpha risk

References

Azzalini, Adelchi, and Antonella Capitanio. "Distributions generated by perturbation of symmetry with emphasis on a multivariate skew t-distribution." *Journal of the Royal Statistical Society: Series B (Statistical Methodology)* 65.2 (2003): 367-389.

Azzalini, Adelchi, and Maintainer Adelchi Azzalini. "Package 'sn'." *The skew-normal and skew-t distributions* (2015): 1-3.

Examples

```
f_VaR(0.95, "gaussian", params=c(0,1))
```

Index

data_euro, 2

data_US, 2

f_compile_quantile, 3

f_distrib, 4

f_distrib_histo, 5

f_ES, 7

f_VaR, 8