Package ‘MultiATSM’

June 2, 2022

Type Package

Title Multicountry Term Structure of Interest Rates Models

Version 0.2.2

Date 2022-06-02

Author Rubens Moura

Maintainer Rubens Moura <rubens.gtmoura@gmail.com>

Description Estimation routines for several classes of affine term structure of interest rates models. All the models are based on the single-country unspanned macroeconomic risk framework from Joslin, Priebsch, and Singleton (2014) <doi:10.1111/jofi.12131>. Multicountry extensions such as the ones of Jotikasthira, Le, and Lundblad (2015) <doi:10.1016/j.jfineco.2014.09.004> and Candelon and Moura (2021) <http://hdl.handle.net/2078.1/249985> are also available.

License GPL-2 | GPL-3

Encoding UTF-8

RoxygenNote 7.1.1

Imports zoo, pracma, wrapr, hablar, ggplot2

Suggests readxl, readr, magic, Jmisc, functional, cowplot, powerplus, reshape2, sjmisc, stringr, knitr, rmarkdown, bookdown, kableExtra, neldermead, magrittr

Depends R (>= 3.5.0)

VignetteBuilder knitr

NeedsCompilation no

Repository CRAN

Date/Publication 2022-06-02 11:30:10 UTC

R topics documented:

A0N_MLEdensity_WOE__jointQ_Bootstrap .............................................. 4
A0N_MLEdensity_WOE__jointQ_sepSigma_Bootstrap ..................................... 6
A0N_MLEdensity_WOE__sepQ_Bootstrap .................................................. 8
A0N__computeBnAn_jointQ .................................................. 10
A0N__computeBnAn_sepQ .................................................. 11
aux2true ................................................................. 12
Bootstrap ................................................................. 13
BootstrapBoundsSet ...................................................... 14
bound2x .................................................................. 15
BR_jps_out ............................................................... 16
BUnspannedAdapJoint .................................................... 16
BUnspannedAdapSep ...................................................... 17
BUnspannedAdapSep_BS .................................................. 17
contain ................................................................. 18
DatabasePrep ........................................................... 19
DataForEstimation ...................................................... 20
DataSet_BS ............................................................ 21
df__dx ................................................................. 22
FactorsGVAR ............................................................ 23
FEVDandGFEVDbs_jointQ ................................................ 23
FEVDandGFEVDbs_jointQ_Ortho .................................... 24
FEVDandGFEVDbs_sepQ ................................................ 25
FEVDgraphsJLLOrtho ................................................... 25
FEVDgraphsJoint ...................................................... 26
FEVDgraphsSep ........................................................ 27
FEVDjoint ............................................................... 28
FEVDjointOrthogoJLL .................................................. 28
FEVDjointOrthogoJLL_BS ............................................. 29
FEVDjoint_BS .......................................................... 29
FEVDsep ............................................................... 30
FEVDsep_BS ........................................................... 31
FitgraphsJoint ........................................................ 31
FitgraphsSep ........................................................... 32
FMN__Rotate ........................................................... 33
ForecastYields .......................................................... 34
ForecastYieldsJointQ .................................................. 35
ForecastYieldsSepQ .................................................... 36
Functionf .............................................................. 37
Functionf_Boot ........................................................ 37
f_with_vectorized_parameters ....................................... 38
GaussianDensity ........................................................ 40
getpara ................................................................. 40
gtx ................................................................. 41
GFEVDgraphsJLLOrtho ................................................ 42
GFEVDgraphsJoint ..................................................... 42
GFEVDgraphsSep ...................................................... 43
GFEVDjoint ............................................................ 44
GFEVDjointOrthogoJLL .............................................. 45
GFEVDjointOrthogoJLL_BS ......................................... 45
GFEVDjoint_BS ........................................................ 46
GFEVDsep .............................................................. 47
R topics documented:

GFEVDsep_BS .................................................. 48
GIRFgraphsJLLOrtho ........................................... 48
GIRFgraphsJoint ................................................. 49
GIRFgraphsSep .................................................. 50
GIRFjoint .......................................................... 50
GIRFjointOrthoJLL ................................................ 51
GIRFjointOrthoJLL_BS .......................................... 52
GIRFjoint_BS ..................................................... 53
GIRFSep ........................................................... 53
GIRFSep_BS ....................................................... 54
GraphicalOutputs .................................................. 55
GVAR ............................................................... 55
IdxAllSpanned .................................................... 57
IdxSpanned ......................................................... 57
InputsForMLEdensity ........................................... 58
InputsForMLEdensity_BS ................................. 60
InputsForOutputs ................................................ 61
IRFandGIRFs_jointQ ........................................... 63
IRFandGIRFs_jointQ_Ortho ................................... 64
IRFandGIRFs_sepQ ............................................... 65
IRFgraphsJLLOrtho .............................................. 65
IRFgraphsJoint ................................................... 66
IRFgraphsSep ..................................................... 67
IRFjoint ........................................................... 68
IRFjointOrthoJLL ................................................ 68
IRFjointOrthoJLL_BS ........................................... 69
IRFjoint_BS ....................................................... 69
IRFsep ............................................................. 70
IRFsep_BS ........................................................ 71
JLL ................................................................. 71
K1XQStationary .................................................. 73
killa ................................................................. 73
LabelsSpanned ..................................................... 74
LabelsStar .......................................................... 74
LabFac ............................................................... 74
Maturities .......................................................... 75
MLEdensity_jointQ ............................................. 76
MLEdensity_jointQ_sepSigma ................................... 77
MLEdensity_sepQ ................................................ 79
ModelPara .......................................................... 81
MultiATSM ........................................................ 81
NumOutputs ......................................................... 82
NumOutputs_Bootstrap .......................................... 83
Optimization ......................................................... 83
Optimization_Boot ............................................... 85
OutputConstructionJoint ...................................... 87
OutputConstructionJoint_BS ................................... 87
OutputConstructionSep ......................................... 88
A0N_MLEdensity_WOE__jointQ_Bootstrap

Compute the maximum likelihood function (joint Q models) - Bootstrap version

Description

Compute the maximum likelihood function (joint Q models) - Bootstrap version
Usage

A0N_MLEdensity_WOE__jointQ_Bootstrap( 
    K1XQ,  
    r0,  
    SSZ,  
    K0Z,  
    K1Z,  
    se,  
    Gy.0,  
    mat,  
    Y,  
    Z,  
    P,  
    Wpca,  
    We,  
    WpcaFull,  
    dt,  
    Economies,  
    FactorLabels,  
    ModelType,  
    residBS,  
    MaxEigen,  
    GVARinputs,  
    JLLinputs,  
    nargout  
)

Arguments

K1XQ risk-neutral feedback matrix (NxN)

r0 long-run interest rate (scalar)

SSZ variance-covariance matrix (KxK)

K0Z intercept from the P-dynamics (Kx1)

K1Z feedback matrix from the P-dynamics (KxK)

se Variance of the portfolio of yields observed with error (scalar)

Gy.0 matrix of contemporaneous terms from the P-dynamics (KxK)

mat vector of maturities (in years) of yields used in estimation (J x 1)

Y matrix of yields used in estimation (J x T)

Z complete set of spanned and unspanned factors (KxT)

P complete set of spanned factors (NxT)

Wpca matrix of weights of the portfolios observed without errors (NxJ)

We matrix of weights of the portfolios observed with errors ((J-N)xJ)

WpcaFull composite matrix of weights the portfolios observed with and without errors
dt  time interval unit of the model (scalar). For instance, if data is (i) monthly, dt <- 12; (ii) quarterly, dt <- 4; (iii) yearly, dt <- 1.

Economies  a string-vector containing the names of the economies which are part of the economic system

FactorLabels  string-list based which contains the labels of all the variables present in the model

ModelType  feasible options are (i) "VAR jointQ", (ii) "GVAR jointQ" or (iii) "JLL jointSigma"

residBS  index of the re-ordered bootstrap residuals

MaxEigen  largest eigenvalue under the P-dynamics

GVARinputs  if the model chosen is the "GVAR sepQ", "GVARinputs" should be specified (see "GVAR" function)

JLLinputs  if the model chosen is the "JLL jointSigma", "JLLinputs" should be specified (see "JLL" function)

nargout  if nargout== 1: provides only the values of the likelihood; if nargout== 2: complete ATSM outputs

References

This function is modified version of the "A0N_MLEdensity_WOE" function by Le and Singleton (2018).
"A Small Package of Matlab Routines for the Estimation of Some Term Structure Models."
(Euro Area Business Cycle Network Training School - Term Structure Modelling). Available at: https://cepr.org/40029

---

Compute the maximum likelihood function ("joint Q" models for separate Sigma estimation) - Bootstrap version

Description

Compute the maximum likelihood function ("joint Q" models for separate Sigma estimation) - Bootstrap version

Usage

A0N_MLEdensity_WOE__jointQ_sepSigma_Bootstrap(  K1XQ,  r0,  SSZ,  K0Z,  K1Z,  se,  Gy.0,  mat,
Arguments

- \( K1XQ \): risk-neutral feedback matrix (NxN)
- \( r0 \): long-run interest rate (scalar)
- \( SSZ \): variance-covariance matrix (KxK)
- \( K0Z \): intercept from the P-dynamics (Kx1)
- \( K1Z \): feedback matrix from the P-dynamics (KxK)
- \( se \): Variance of the portfolio of yields observed with error (scalar)
- \( Gy.0 \): matrix of contemporaneous terms from the P-dynamics (KxK)
- \( mat \): vector of maturities (in years) of yields used in estimation (J x 1)
- \( Y \): matrix of yields used in estimation (J x T)
- \( Z \): complete set of spanned and unspanned factors (KxT)
- \( P \): complete set of spanned factors (NxT)
- \( Wpca \): matrix of weights of the portfolios observed without errors (NxJ)
- \( We \): matrix of weights of the portfolios observed with errors ((J-N)xJ)
- \( WpcaFull \): composite matrix of weights the portfolios observed with and without errors
- \( dt \): time interval unit of the model (scalar). For instance, if data is (i) monthly, \( dt \) <- 12; (ii) quarterly, \( dt \) <- 4; (iii) yearly, \( dt \) <- 1.
- \( Economies \): a string-vector containing the names of the economies which are part of the economic system
- \( FactorLabels \): string-list based which contains the labels of all the variables present in the model
- \( ModelType \): feasible options are (i) "JLL original" or (ii) "JLL NoDomUnit"
- \( residBS \): indexes of the re-ordered bootstrap residuals
- \( MaxEigen \): largest eigenvalue under the P-dynamics
A0N_MLEdensity_WOE__sepQ_Bootstrap

Description

Compute the maximum likelihood function ("sep Q" models) - Bootstrap version

Usage

A0N_MLEdensity_WOE__sepQ_Bootstrap(
    K1XQ,
    r0,
    SSZ,
    K0Z,
    K1Z,
    se,
    Gy.0,
    mat,
    Y,
    Z,
    P,
    Wpca,
    We,
    WpcaFull,
    dt,
    Economy,
    FactorLabels,
    ModelType,
    residBS,
)

References

This function is modified version of the "A0N_MLEdensity_WOE" function by Le and Singleton (2018).
"A Small Package of Matlab Routines for the Estimation of Some Term Structure Models."
(Euro Area Business Cycle Network Training School - Term Structure Modelling). Available at: https://cepr.org/40029
Arguments

- **K1XQ**: risk-neutral feedback matrix (NxN)
- **r0**: long-run interest rate (scalar)
- **SSZ**: variance-covariance matrix (KxK)
- **K0Z**: intercept from the P-dynamics (Kx1)
- **K1Z**: feedback matrix from the P-dynamics (KxK)
- **se**: Variance of the portfolio of yields observed with error (scalar)
- **Gy.0**: matrix of contemporaneous terms from the P-dynamics (KxK)
- **mat**: vector of maturities (in years) of yields used in estimation (J x 1)
- **Y**: matrix of yields used in estimation (J x T)
- **Z**: complete set of spanned and unspanned factors (KxT)
- **P**: complete set of spanned factors (NxT)
- **Wpca**: matrix of weights of the portfolios observed without errors (NxJ)
- **We**: matrix of weights of the portfolios observed with errors ((J-N)xJ)
- **WpcaFull**: composite matrix of weights the portfolios observed with and without errors
- **dt**: time interval unit of the model (scalar). For instance, if data is (i) monthly, dt <- 12; (ii) quarterly, dt <- 4; (iii) yearly, dt <- 1.

Economy

- **Economy**: Name of the economies under study

FactorLabels

- **FactorLabels**: string-list based which contains the labels of all the variables present in the model

ModelType

- **ModelType**: Feasible options are: (i) "JPS", (ii) "JPS jointP" or (iii) "GVAR sepQ"

residBS

- **residBS**: index of the re-ordered bootstrap residuals

MaxEigen

- **MaxEigen**: largest eigenvalue under the P-dynamics

GVARinputs

- **GVARinputs**: if the model chosen is the "GVAR sepQ", "GVARinputs" should be specified (see "GVAR" function)

nargout

- **nargout**: if nargout== 1: provides only the values of the likelihood; if nargout== 2: complete ATSM outputs

References

This function is modified version of the "A0N_MLEdensity_WOE" function by Le and Singleton (2018).

"A Small Package of Matlab Routines for the Estimation of Some Term Structure Models."
(Euro Area Business Cycle Network Training School - Term Structure Modelling). Available at: https://cepr.org/40029
A0N__computeBnAn_jointQ

Compute the cross-section loadings of yields of a canonical A0_N model ("joint Q" models)

Description
Compute the cross-section loadings of yields of a canonical A0_N model ("joint Q" models)

Usage
A0N__computeBnAn_jointQ(mat, K1XQ, dx, r0, SSX, Economies)

Arguments
mat vector of maturities (J x 1). Maturities are in multiples of the discrete interval used in the model
K1XQ risk neutral feedback matrix (N x N)
dx state loadings for the one-period rate (1xN). Default is a vector of ones
r0 the long run risk neutral mean of the short rate (scalar)
SSX the covariance matrix of the errors (N x N)
Economies Set of economies that are part of the economic system (vector of text)

Value
List containing:
  • Intercept (Jx1)
  • slope (JxN)
  • the betan (Jx1, part of the intercepts unrelated to the long run risk neutral mean r0) coefficients of a canonical A_0(N).

References
This function is an extended version of the "A0N__computeBnAn" function by Le and Singleton (2018).
A0N__computeBnAn_sepQ

Compute the cross-section loadings of yields of a canonical A0_N model ("sep Q" models)

Description

Compute the cross-section loadings of yields of a canonical A0_N model ("sep Q" models)

Usage

A0N__computeBnAn_sepQ(mat, K1XQ, dx, r0, SSX)

Arguments

- mat: vector of maturities (J x 1). Maturities are in multiples of the discrete interval used in the model
- K1XQ: risk neutral feedback matrix (N x N)
- dx: state loadings for the one-period rate (1xN). Default is a vector of ones
- r0: the long run risk neutral mean of the short rate (scalar)
- SSX: the covariance matrix of the errors (N x N)

Value

List containing:

- Intercept (Jx1)
- slope (JxN)
- the betan (JX1, part of the intercepts unrelated to the long run risk neutral mean r0) coefficients of a canonical A_0(N).

References

- This function is based on the "A0N__computeBnAn" function by Le and Singleton (2018). "A Small Package of Matlab Routines for the Estimation of Some Term Structure Models." (Euro Area Business Cycle Network Training School - Term Structure Modelling). Available at: https://cepr.org/40029
aux2true

Map auxiliary (unconstrained) parameters $a$ to constrained parameters $b$.

**Usage**

```r
aux2true(
  a,
  ctype,
  lb,
  ub,
  FactorLabels,
  Economies,
  JLLinputs = NULL,
  GVARinputs = NULL,
  nargout
)
```

**Arguments**

- **a**: unconstrained auxiliary parameter
- **ctype**: One of the following options:
  - 'Jordan'
  - 'Jordan; stationary'
  - 'Jordan MultiCountry'
  - 'Jordan MultiCountry; stationary'
  - 'psd';
  - 'BlockDiag'
  - 'bounded'
  - 'diag'
  - 'JLLstructure'
- **lb**: lower bounds of $b$ (if option 'bounded' is chosen)
- **ub**: upper bounds of $b$ (if option 'bounded' is chosen)
- **FactorLabels**: string-list based which contains the labels of all the variables present in the model
- **Economies**: string-vector containing the names of the economies which are part of the economic system
- **JLLinputs**: Inputs used in the estimation of the JLL-based models
- **GVARinputs**: Inputs used in the estimation of the GVAR-based models
- **nargout**: 
  - "nargout <- 1" returns a constrained scalar or matrix
  - "nargout <- 2" returns a list of parameters
References

This function is a modified version of the "aux2true" function by Le and Singleton (2018). "A Small Package of Matlab Routines for the Estimation of Some Term Structure Models." (Euro Area Business Cycle Network Training School - Term Structure Modelling). Available at: https://cepr.org/40029

Bootstrap

Generates the bootstrap-related outputs

Description

Generates the bootstrap-related outputs

Usage

Bootstrap(
    ModelType, 
    ModelParaPE, 
    NumOutPE, 
    mat, 
    Economies, 
    InputsForOutputs, 
    FactorLabels, 
    DataFrequency, 
    vararginPE, 
    JLLinputs = NULL, 
    GVARinputs = NULL
)

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ModelType</td>
<td>string-vector containing the label of the model to be estimated</td>
</tr>
<tr>
<td>ModelParaPE</td>
<td>point estimate from the model parameters (see the outputs of the &quot;Optimization&quot; function)</td>
</tr>
<tr>
<td>NumOutPE</td>
<td>point estimate from the numerical outputs (see the outputs of the &quot;NumOutputs&quot; function)</td>
</tr>
<tr>
<td>mat</td>
<td>vector of maturities (in years) used in the estimation</td>
</tr>
<tr>
<td>Economies</td>
<td>string-vector containing the names of the economies which are part of the economic system</td>
</tr>
<tr>
<td>InputsForOutputs</td>
<td>list containing the desired inputs for the construction of IRFs, GIRFs, FEVDs, and GFEVDs.</td>
</tr>
<tr>
<td>FactorLabels</td>
<td>string-list based which contains the labels of all the variables present in the model</td>
</tr>
</tbody>
</table>
BootstrapBoundsSet


varginPE list containing starting values and constraints (see arguments of the "Optimization" function)

JLLinputs list of necessary inputs for the estimation of JLL-based models (see "JLL" function)

GVARinputs list of necessary inputs for the estimation of GVAR-based models (see "GVAR" function)

Value

list containing the following elements:

- list of model parameters for one each one the draws;
- list of numerical outputs (IRFs, GIRFs, FEVDs, GFEVDs) for each one of the draws;
- Confidence bands for the chosen level of significance.

References

This function is a modified and extended version of the "VARirbound" function from "A toolbox for VAR analysis" by Ambrogio Cesa-Bianchi (https://github.com/ambropo/VAR-Toolbox)

Examples

# See examples in the vignette file of this package (Section 4).

BootstrapBoundsSet Builds the confidence bounds and graphs (Bootstrap set)

Description

Builds the confidence bounds and graphs (Bootstrap set)

Usage

BootstrapBoundsSet(
    ModelType,
    ModelBootstrap,
    NumOutPE,
    InputsForOutputs,
    Economies
)
bound2x

Arguments

ModelType string-vector containing the label of the model to be estimated
ModelBootstrap list containing the complete set of model parameters after the bootstrap estimation procedure
NumOutPE point estimate from the numerical outputs (see the outputs of the "NumOutputs" function)
InputsForOutputs list containing the desired inputs for the construction of IRFs, GIRFs, FEVDs, and GFEVDs
Economies string-vector containing the names of the economies which are part of the economic system

bound2x Transform a number bounded between a lower bound and upper bound to x by:

Description

Transform a number bounded between a lower bound and upper bound to x by:

Usage

bound2x(y, lb, ub)

Arguments

y Number to be transformed (scalar)
lb lower bound (scalar)
ub upper bound (scalar)

References

This function is based on the "bound2x" function by Le and Singleton (2018). "A Small Package of Matlab Routines for the Estimation of Some Term Structure Models." (Euro Area Business Cycle Network Training School - Term Structure Modelling). Available at: https://cepr.org/40029
**BR_jps_out**  
*Replications of the JPS (2014) outputs by Bauer and Rudebusch (2017)*

**Description**

Unspanned macro risk model outputs by Bauer and Rudebusch (2017)

**Usage**

```r
data("BR_jps_gro_R3")
```

**Format**

Unspanned macro risk model outputs by Bauer and Rudebusch (2017)

- `est.llk` summary list of log-likelihood estimations
- `M.o` time series of unspanned factors
- `pars` additional summary list of log-likelihood estimations
- `W` Weight matrix that results from principal components analysis
- `Y` time series of bond yields
- `N` total number of risk factor of the model (spanned and unspanned)
- `R` total number of spanned factor of the model

**References**

Bauer, M. and Rudebusch, G. "Resolving the Spanning Puzzle in Macro-Finance Term Structure Models"

---

**BUnspannedAdapJoint**  
*Transform B_spanned into B_unspanned for jointQ models*

**Description**

Transform B_spanned into B_unspanned for jointQ models

**Usage**

```r
BUnspannedAdapJoint(G, M, N, C, J, BSspanned)
```
Arguments

G  number of global unspanned factors
M  number of domestic unspanned factors
N  number of domestic spanned factors
C  number of economies of the economic system
J  number of country-specific observed bond yields
BSpanned  B that accomodates only the map to the spanned factors only

BUnspannedAdapSep  Transform B_spanned into B_unspanned for sepQ models

Description

Transform B_spanned into B_unspanned for sepQ models

Usage

BUnspannedAdapSep(G, M, ModelPara, Economies, Economy, ModelType)

Arguments

G  number of global unspanned factors
M  number of domestic unspanned factors per country
ModelPara  list of model parameter estimates (See the "Optimization" function)
Economies  complete set of economies of the economic system
Economy  specific economy under study
ModelType  a string-vector containing the label of the model to be estimated

BUnspannedAdapSep_BS  Obtain the full form of B unspanned for "sep Q" models within the bootstrap setting

Description

Obtain the full form of B unspanned for "sep Q" models within the bootstrap setting

Usage

BUnspannedAdapSep_BS(G, M, ModelParaBoot, Economies, Economy, ModelType, tt)
Arguments

- \( G \): number of global unspanned factors
- \( M \): number of country-specific domestic unspanned factors
- \( \text{ModelParaBoot} \): list of model parameter estimates (see the "Optimization" function) after a bootstrap draw
- \( \text{Economies} \): string-vector containing the names of the economies which are part of the economic system
- \( \text{Economy} \): string-vector containing the names of the economy under study
- \( \text{ModelType} \): string-vector containing the label of the model to be estimated
- \( \text{tt} \): number of the bootstrap draw

**contain**

*Check whether one element is a subset of another element*

**Description**

Check whether one element is a subset of another element

**Usage**

\[
\text{contain}(s1, s2)
\]

**Arguments**

- \( s1 \): smaller subset
- \( s2 \): complete set

**References**

This function is based on the "contain" function by Le and Singleton (2018). "A Small Package of Matlab Routines for the Estimation of Some Term Structure Models." (Euro Area Business Cycle Network Training School - Term Structure Modelling). Available at: https://cepr.org/40029
Description

Prepare the GVARFactors database

Usage

DatabasePrep(
  t.First,
  t.Last,
  Economies,
  N,
  FactorLabels,
  ModelType,
  Wgvar = NULL,
  DataPathMacro = NULL,
  DataPathYields = NULL
)

Arguments

- **t.First**: sample starting date (yyyy-mm-dd)
- **t.Last**: sample last date (yyyy-mm-dd)
- **Economies**: string-vector containing the names of the economies which are part of the economic system
- **N**: number of country-specific spanned factor (scalar)
- **FactorLabels**: list containing the factor labels
- **ModelType**: string-vector containing the label of the model to be estimated
- **Wgvar**: GVAR transition matrix (CxC), if GVAR type model is chosen; default is set to NULL.
- **DataPathMacro**: path of the Excel file containing the macroeconomic data (if any). The default is linked to the Excel file available in the package.
- **DataPathYields**: path of the Excel file containing the yields data (if any). The default is linked to the Excel file available in the package.

Value

List of the risk factor set used in the estimation of the GVAR model
List containing the risk factor set used in the estimation of the GVAR-based models
Examples

DomVar <- c("Eco_Act", "Inflation")
GlobalVar <- c("GBC", "CPI_OECD")
t0 <- "2006-09-01"
tF <- "2019-01-01"
Economies <- c("China", "Brazil", "Mexico", "Uruguay", "Russia")
N <- 3
ModelType <- "JPS jointQ"
FactorLabels <- LabFac(N, DomVar, GlobalVar, Economies, ModelType)

GVARFactors <- DatabasePrep(t0, tF, Economies, N, FactorLabels, ModelType)

DataForEstimation

Retrieve data from Excel and build the database used in the model estimation

Description

Retrieve data from Excel and build the database used in the model estimation

Usage

DataForEstimation(
  t0, 
tF, 
Economies, 
N, 
FactorLabels, 
ModelType, 
DataFrequency, 
DataPathMacro = NULL, 
DataPathYields = NULL, 
Wgvar = NULL
)

Arguments

t0    Sample starting date (yyyy-mm-dd)
tF    Sample last date (yyyy-mm-dd)
Economies    string-vector containing the names of the economies which are part of the economic system
N    Number of country-specific spanned factor (scalar)
FactorLabels    String-list based which contains the labels of all the variables present in the model
ModelType String-vector containing the label of the model to be estimated
DataPathMacro Path of the Excel file containing the macroeconomic data (if any). The default is linked to the excel file present in the package.
DataPathYields Path of the Excel file containing the yields data (if any). The default is linked to the excel file present in the package.
Wgvar GVAR transition matrix, if GVAR type model is chosen; default is set to NULL.

Value
A list containing the
1. time series of the complete set of bond yields (matrix, JxT or CJxT);
2. time series of the complete set risk factors (matrix, KxT);
3. 'GVARFactors': list of all variables that are used in the estimation of the VARX (see e.g. 'CM_Factors_GVAR' file). If the estimated model type is not GVAR-based, then returns NULL.

Examples
```
DomVar <- c("Eco_Act", "Inflation")
GlobalVar <- c("GBC", "CPI_OECD")
t0 <- "2006-09-01"
tF <- "2019-01-01"
Economies <- c("China", "Brazil", "Mexico", "Uruguay", "Russia")
N <- 2
ModelType <- "JPS"
FactorLabels <- LabFac(N, DomVar, GlobalVar, Economies, ModelType)
DataFrequency <- "Monthly"

DataModel <- DataForEstimation(t0, tF, Economies, N, FactorLabels, ModelType, DataFrequency)
```

DataSet_BS

Prepare the factor set for GVAR models (Bootstrap version)

Description
Prepare the factor set for GVAR models (Bootstrap version)

Usage
DataSet_BS(ModelType, RiskFactors, Wgvar, Economies, FactorLabels)
Arguments

- **ModelType**: string-vector containing the label of the model to be estimated
- **RiskFactors**: Complete set of risk factors (KxT)
- **Wgvar**: transition matrix from GVAR models (CxC)
- **Economies**: string-vector containing the names of the economies which are part of the economic system
- **FactorLabels**: string-list based which contains the labels of all the variables present in the model

---

**df__dx**  
*Computes numerical first order derivative of f(x)*

---

**Description**

Computes numerical first order derivative of f(x)

**Usage**

```matlab
df__dx(f, x)
```

**Arguments**

- **f**: function which contains vector (J x T) valued function handle
- **x**: parameter values

**Value**

transformed matrix (MN x JT)

**References**

This function is based on the "df__dx" function by Le and Singleton (2018).  
"A Small Package of Matlab Routines for the Estimation of Some Term Structure Models."  
(Euro Area Business Cycle Network Training School - Term Structure Modelling). Available at:  
https://cepr.org/40029
Data: Risk Factors for the GVAR - Candelon and Moura (2021)

Description
Risk factors data used in the GVAR models - Candelon and Moura (2021)

Usage
data("CM_Factors_GVAR")

Format
list containing the variables used in the GVAR models

References
Candelon, B. and Moura, R. "A Multi-Country Model of the Term Structures of Interest Rates with a GVAR".

FEVDandGFEVDbs_jointQ  Creates the confidence bounds and the graphs of FEVDs and GFEVDs after bootstrap ("joint Q" models)

Description
Creates the confidence bounds and the graphs of FEVDs and GFEVDs after bootstrap ("joint Q" models)

Usage
FEVDandGFEVDbs_jointQ(
  ModelType,
  ModelBootstrap,
  NumOutPE,
  InputsForOutputs,
  Economies,
  PathsGraphs
)
### Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ModelType</td>
<td>string-vector containing the label of the model to be estimated</td>
</tr>
<tr>
<td>ModelBootstrap</td>
<td>list containing the complete set of model parameters after bootstrap estimation procedure</td>
</tr>
<tr>
<td>NumOutPE</td>
<td>list of model parameter point estimates</td>
</tr>
<tr>
<td>InputsForOutputs</td>
<td>list containing the desired inputs for the construction of the outputs of interest</td>
</tr>
<tr>
<td>Economies</td>
<td>string-vector containing the names of the economies which are part of the economic system</td>
</tr>
<tr>
<td>PathsGraphs</td>
<td>path of the folder in which the graphs will be saved</td>
</tr>
</tbody>
</table>

### Description

*FEVDandGFEVDbJointQ_Ortho*

* Creates the confidence bounds and the graphs of FEVDs and GFEVDs after bootstrap (JLL-based models)*

### Usage

```r
FEVDandGFEVDbJointQ_Ortho(
  ModelType,
  ModelBootstrap,
  NumOutPE,
  InputsForOutputs,
  Economies,
  PathsGraphs
)
```

### Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ModelType</td>
<td>string-vector containing the label of the model to be estimated</td>
</tr>
<tr>
<td>ModelBootstrap</td>
<td>list containing the complete set of model parameters after bootstrap estimation procedure</td>
</tr>
<tr>
<td>NumOutPE</td>
<td>list of model parameter point estimates</td>
</tr>
<tr>
<td>InputsForOutputs</td>
<td>list containing the desired inputs for the construction of the outputs of interest</td>
</tr>
<tr>
<td>Economies</td>
<td>a string-vector containing the names of the economies which are part of the economic system</td>
</tr>
<tr>
<td>PathsGraphs</td>
<td>path of the folder in which the graphs will be saved</td>
</tr>
</tbody>
</table>
FEVDandGFEVDbs_sepQ

*Description*

Creates the confidence bounds and the graphs of FEVDs and GFEVDs after bootstrap ("sep Q" models)

*Usage*

```r
FEVDandGFEVDbs_sepQ(
  ModelType,
  ModelBootstrap,
  NumOutPE,
  InputsForOutputs,
  Economies,
  PathsGraphs
)
```

*Arguments*

- **ModelType**: string-vector containing the label of the model to be estimated
- **ModelBootstrap**: list containing the complete set of model parameters after bootstrap estimation procedure
- **NumOutPE**: list of model parameter point estimates
- **InputsForOutputs**: list containing the desired inputs for the construction of the outputs of interest
- **Economies**: string-vector containing the names of the economies which are part of the economic system
- **PathsGraphs**: path of the folder in which the graphs will be saved

---

**FEVDgraphsJLLOrtho**

*Description*

FEVDs graphs for orthogonalized risk factors of JLL-based models
Usage

FEVDgraphsJoint(
    ModelType,
    NumOut,
    WishPdynamicsgraphs,
    WishYieldsgraphs,
    FEVDhoriz,
    PathsGraphs
)

Arguments

ModelType a string-vector containing the label of the model to be estimated
NumOut list of computed outputs containing the model fit, IRFs, FEVDs, GIRFs, and GFEVDs
WishPdynamicsgraphs binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise
WishYieldsgraphs binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise
FEVDhoriz single numerical vector containing the desired horizon of analysis for the FEVDs
PathsGraphs Path of the folder in which the graphs will be saved

Description

FEVDs graphs for ("joint Q" models)

Usage

FEVDgraphsJoint(
    ModelType,
    NumOut,
    WishPdynamicsgraphs,
    WishYieldsgraphs,
    FEVDhoriz,
    PathsGraphs
)
FEVDgraphsSep

Arguments

ModelType  a string-vector containing the label of the model to be estimated
NumOut    list of computed outputs containing the model fit, IRFs, FEVDs, GIRFs, and GFEVDs
WishPdynamicsgraphs binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise
WishYieldsgraphs binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise
FEVDhoriz single numerical vector containing the desired horizon of analysis for the FEVDs
PathsGraphs Path of the folder in which the graphs will be saved
Economies  a string-vector containing the names of the economies which are part of the economic system

Description

FEVDs graphs for ("sep Q" models)

Usage

FEVDgraphsSep(
  ModelType,
  NumOut,
  WishPdynamicsgraphs,
  WishYieldsgraphs,
  FEVDhoriz,
  PathsGraphs,
  Economies
)

Arguments

ModelType  a string-vector containing the label of the model to be estimated
NumOut    list of computed outputs containing the model fit, IRFs, FEVDs, GIRFs, and GFEVDs
WishPdynamicsgraphs binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise
WishYieldsgraphs binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise
FEVDhoriz single numerical vector containing the desired horizon of analysis for the FEVDs
PathsGraphs Path of the folder in which the graphs will be saved
Economies  a string-vector containing the names of the economies which are part of the economic system
FEVDjoint

FEVDs for "joint Q" models

Description

FEVDs for "joint Q" models

Usage

FEVDjoint(ModelType, ModelPara, FEVDhoriz, FactorLabels, Economies)

Arguments

- **ModelType**: string-vector containing the label of the model to be estimated
- **ModelPara**: list of model parameter estimates (see the "Optimization" function)
- **FEVDhoriz**: single numerical vector containing the desired horizon of analysis for the FEVDs
- **FactorLabels**: string-list based which contains all the labels of all the variables present in the model
- **Economies**: string-vector containing the names of the economies which are part of the economic system

Details

Structural shocks are identified via Cholesky decomposition

FEVDjointOrthogoJLL

Orthogonalized FEVDs for JLL models

Description

Orthogonalized FEVDs for JLL models

Usage

FEVDjointOrthogoJLL(ModelType, ModelPara, FEVDhoriz, FactorLabels, Economies)

Arguments

- **ModelType**: string-vector containing the label of the model to be estimated
- **ModelPara**: list of model parameter estimates (see the "Optimization" function)
- **FEVDhoriz**: single numerical vector containing the desired horizon of analysis for the FEVDs
- **FactorLabels**: string-list based which contains all the labels of all the variables present in the model
- **Economies**: a string-vector containing the names of the economies which are part of the economic system
Details

Structural shocks are identified via Cholesky decomposition

FEVDjointOrthogoJLL_BS

FEVDs after bootstrap for JLL-based models

Description

FEVDs after bootstrap for JLL-based models

Usage

FEVDjointOrthogoJLL_BS(
    ModelType,
    ModelParaBoot,
    FEVDhoriz,
    FactorLabels,
    Economies
)

Arguments

ModelType: string-vector containing the label of the model to be estimated
ModelParaBoot: list of model parameter estimates (see the "Optimization" function) after a bootstrap draw
FEVDhoriz: single numerical vector containing the desired horizon of analysis for the FEVDs
FactorLabels: string-list based which contains all the labels of all the variables present in the model
Economies: string-vector containing the names of the economies which are part of the economic system

FEVDjoint_BS

FEVDs after bootstrap for "joint Q" models

Description

FEVDs after bootstrap for "joint Q" models

Usage

FEVDjoint_BS(ModelType, ModelParaBoot, FEVDhoriz, FactorLabels, Economies)
### Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ModelType</td>
<td>string-vector containing the label of the model to be estimated</td>
</tr>
<tr>
<td>ModelPara</td>
<td>list of model parameter estimates (see the &quot;Optimization&quot; function) after a bootstrap draw</td>
</tr>
<tr>
<td>FEVDhoriz</td>
<td>single numerical vector containing the desired horizon of analysis for the FEVDs</td>
</tr>
<tr>
<td>FactorLabels</td>
<td>string-list based which contains all the labels of all the variables present in the model</td>
</tr>
<tr>
<td>Economies</td>
<td>string-vector containing the names of the economies which are part of the economic system</td>
</tr>
</tbody>
</table>

### Description

FEVDs for "sep Q" models

### Usage

FEVDsep(ModelType, ModelPara, FEVDhoriz, FactorLabels, Economies)

### Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ModelType</td>
<td>string-vector containing the label of the model to be estimated</td>
</tr>
<tr>
<td>ModelPara</td>
<td>list of model parameter estimates (see the &quot;Optimization&quot; function)</td>
</tr>
<tr>
<td>FEVDhoriz</td>
<td>single numerical vector containing the desired horizon of analysis for the FEVDs</td>
</tr>
<tr>
<td>FactorLabels</td>
<td>string-list based which contains all the labels of all the variables present in the model</td>
</tr>
<tr>
<td>Economies</td>
<td>string-vector containing the names of the economies which are part of the economic system</td>
</tr>
</tbody>
</table>

### Details

Structural shocks are identified via Cholesky decomposition
FEVDsep_BS  

**FEVDs after bootstrap for "sep Q" models**

**Description**

FEVDs after bootstrap for "sep Q" models

**Usage**

FEVDsep_BS(ModelType, ModelParaBoot, FEVDhoriz, FactorLabels, Economies)

**Arguments**

- **ModelType**: string-vector containing the label of the model to be estimated
- **ModelParaBoot**: list of model parameter estimates (see the "Optimization" function) after a bootstrap draw
- **FEVDhoriz**: single numerical vector containing the desired horizon of analysis for the FEVDs
- **FactorLabels**: string-list based which contains all the labels of all the variables present in the model
- **Economies**: string-vector containing the names of the economies which are part of the economic system

---

FitgraphsJoint  

**Model fit graphs for ("joint Q" models)**

**Description**

Model fit graphs for ("joint Q" models)

**Usage**

FitgraphsJoint(  
  ModelType,  
  WishFitgraphs,  
  ModelPara,  
  NumOut,  
  Economies,  
  PathsGraphs  
)
**Arguments**

- **ModelType**: a string-vector containing the label of the model to be estimated
- **WishFitgraphs**: binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise
- **ModelPara**: List of model parameter estimates (See the "Optimization" function)
- **NumOut**: list of computed outputs containing the model fit, IRFs, FEVDs, GIRFs, and GFEVDs
- **Economies**: a string-vector containing the names of the economies which are part of the economic system
- **PathsGraphs**: Path of the folder in which the graphs will be saved

---

**FitgraphsSep**  
*Model fit graphs for ("sep Q" models)*

**Description**

Model fit graphs for ("sep Q" models)

**Usage**

```r
FitgraphsSep(
  ModelType,   
  WishFitgraphs,  
  ModelPara, 
  NumOut,  
  Economies,  
  PathsGraphs
)
```

**Arguments**

- **ModelType**: a string-vector containing the label of the model to be estimated
- **WishFitgraphs**: binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise
- **ModelPara**: List of model parameter estimates (See the "Optimization" function)
- **NumOut**: list of computed outputs containing the model fit, IRFs, FEVDs, GIRFs, and GFEVDs
- **Economies**: a string-vector containing the names of the economies which are part of the economic system
- **PathsGraphs**: Path of the folder in which the graphs will be saved
**FMN__Rotate**  
*Performs state rotations*

---

**Description**

Performs state rotations

**Usage**

```plaintext
FMN__Rotate(y0, U1, U0)
```

**Arguments**

- `y0`: list of model parameters as described below
- `U1`: matrix (N x N)
- `U0`: vector (N x 1). Optional. Default: vector of zeros.

**Details**

This function performs a rotation from a model with Z as states to one with S = U0 + U1*Z as states.

Specifically, each model is characterized by the following inputs organized in a list of variables:

(i) `K0`: intercepts (N x 1);
(ii) `K1`: feedback matrix (N x N*p);
(iii) `SS`: volatility matrices (N x N*(M+1))

More specifically, the state Z follows the dynamics:

\[
Z_t = N(K0 + K1 [Z_{t-1}; Z_{t-2}; \ldots], SS[\ldots, 1] + \text{sum}_{i=1}^{M} SS[\ldots, i+1]) \quad \text{where } SS_i \leftarrow \text{array}(SS, c(N, N, M+1))
\]

**Value**

`y1` - list of outputs after the transformation, the structure parallels that of `y0`

**References**

# This function is modified version of the "FMN__Rotate" function by Le and Singleton (2018).  
"A Small Package of Matlab Routines for the Estimation of Some Term Structure Models."  
(Euro Area Business Cycle Network Training School - Term Structure Modelling). Available at:  
https://cepr.org/40029
**ForecastYields**

Gather bond yields forecasts for all the model types

**Description**

Gather bond yields forecasts for all the model types

**Usage**

```
ForecastYields(
    ModelType,  # a string-vector containing the label of the model to be estimated
    ModelPara,  # List of model parameter estimates (See the "Optimization" function)
    InputsForOutputs,  # list containing the desired horizon of analysis for the IRFs, GIRFs, FEVDs, and GFEVDs
    FactorLabels,  # a string-list based which contains all the labels of all the variables present in the model
    Economies,  # string-vector containing the names of the economies which are part of the economic system
    JLLinputs,  # list of necessary inputs for the estimation of JLL-based models (see "JLL" function)
    GVARinputs  # list of necessary inputs for the estimation of GVAR-based models (see "GVAR" function)
)
```

**Arguments**

- **ModelType**
  a string-vector containing the label of the model to be estimated

- **ModelPara**
  List of model parameter estimates (See the "Optimization" function)

- **InputsForOutputs**
  list containing the desired horizon of analysis for the IRFs, GIRFs, FEVDs, and GFEVDs

- **FactorLabels**
  a string-list based which contains all the labels of all the variables present in the model

- **Economies**
  string-vector containing the names of the economies which are part of the economic system

- **DataFrequency**

- **JLLinputs**
  list of necessary inputs for the estimation of JLL-based models (see "JLL" function)

- **GVARinputs**
  list of necessary inputs for the estimation of GVAR-based models (see "GVAR" function)

**Value**

List containing the following elements

1. Out-of-sample forecasts of bond yields per forecast horizon
2. Out-of-sample forecast errors of bond yields per forecast horizon
3. Root mean square errors per forecast horizon
ForecastYieldsJointQ

Examples

# See examples in the vignette file of this package (Section 4).

---

**ForecastYieldsJointQ**  *Bond yields forecasts ("joint Q" models)*

**Description**

Bond yields forecasts ("joint Q" models)

**Usage**

`ForecastYieldsJointQ(
  ModelType,
  ModelPara,
  InputsForOutputs,
  FactorLabels,
  Economies,
  DataFrequency,
  JLLinputs,
  GVARinputs
)
`

**Arguments**

- **ModelType**: a string-vector containing the label of the model to be estimated
- **ModelPara**: List of model parameter estimates (See the "Optimization" function)
- **InputsForOutputs**: list containing the desired horizon of analysis for the IRFs, GIRFs, FEVDs, and GFEVDs
- **FactorLabels**: a string-list based which contains all the labels of all the variables present in the model
- **Economies**: string-vector containing the names of the economies which are part of the economic system
- **JLLinputs**: list of necessary inputs for the estimation of JLL-based models (see "JLL" function)
- **GVARinputs**: list of necessary inputs for the estimation of GVAR-based models (see "GVAR" function)
ForecastYieldsSepQ  
*Bond yields forecasts ("sep Q" models)*

**Description**

Bond yields forecasts ("sep Q" models)

**Usage**

```r
ForecastYieldsSepQ(
  ModelType,
  ModelPara,
  InputsForOutputs,
  FactorLabels,
  Economies,
  DataFrequency,
  JLLinputs,
  GVARinputs
)
```

**Arguments**

- **ModelType**  
  a string-vector containing the label of the model to be estimated

- **ModelPara**  
  List of model parameter estimates (See the "Optimization" function)

- **InputsForOutputs**  
  list containing the desired horizon of analysis for the IRFs, GIRFs, FEVDs, and GFEVDs

- **FactorLabels**  
  a string-list based which contains all the labels of all the variables present in the model

- **Economies**  
  string-vector containing the names of the economies which are part of the economic system

- **DataFrequency**  

- **JLLinputs**  
  list of necessary inputs for the estimation of JLL-based models (see "JLL" function)

- **GVARinputs**  
  list of necessary inputs for the estimation of GVAR-based models (see "GVAR" function)
**Function**

*Set up the vector-valued objective function (Point estimate)*

**Description**

Set up the vector-valued objective function (Point estimate)

**Usage**

\[\text{Functionf}(\text{MLEinputs, Economies, mat, DataFrequency, FactorLabels, ModelType})\]

**Arguments**

- \text{MLEinputs} \quad \text{Set of inputs that are necessary to the log-likelihood function}
- \text{Economies} \quad \text{string-vector containing the names of the economies which are part of the economic system}
- \text{mat} \quad \text{vector of maturities (in years) of yields used in estimation (J x 1)}
- \text{DataFrequency} \quad \text{character-based vector: "Daily All Days", "Daily Business Days", "Weekly", "Monthly", "Quarterly", "Annually"}
- \text{FactorLabels} \quad \text{string-list based which contains the labels of all the variables present in the model}
- \text{ModelType} \quad \text{string-vector containing the label of the model to be estimated}

**Value**

objective function

**Examples**

\# See examples in the vignette file of this package (Section 4).

---

**Functionf\_Boot**

*Set up the vector-valued objective function (Bootstrap)*

**Description**

Set up the vector-valued objective function (Bootstrap)
Usage

Function f_Boot(
  ModelType,
  MLEinputsBS,
  Economies,
  mat,
  dt,
  FactorLabels,
  residBS,
  MaxEigen,
  JLLinputs,
  GVARinputs
)

Arguments

ModelType: string-vector containing the label of the model to be estimated
MLEinputsBS: Set of inputs that are necessary to the log-likelihood function
Economies: string-vector containing the names of the economies which are part of the economic system
mat: vector of maturities (in years) of yields used in estimation (J x 1)
dt: adjusted yearly frequency of the data
FactorLabels: string-list based which contains the labels of all the variables present in the model
residBS: indexes of the re-ordered bootstrap residuals
MaxEigen: largest eigenvalue under the P-dynamics
JLLinputs: necessary inputs for the estimation of JLL-based models
GVARinputs: necessary inputs for the estimation of GVAR-based models

f_with_vectorized_parameters

Use function f to generate the outputs from a ATSM

Description

Use function f to generate the outputs from a ATSM

Usage

f_with_vectorized_parameters(
  x,
  sizex,
  f,
  con,
f_with_vectorized_parameters

varargin,
ModelType,
FactorLabels,
Economies,
JLLinputs,
GVARinputs,
nargout

Arguments

x        vector containing all the vectorized auxiliary parameters
sizex    matrix (6x2) containing the size information of all parameters
f        vector-valued objective function (function)
con      if con = 'concentration', then set the value of the parameter whose name contains @ to empty
varargin variable inputs used in the optimization (see inputs from "optimization" function)
ModelType string-vector containing the label of the model to be estimated
FactorLabels string-list based which contains the labels of all the variables present in the model
Economies string-vector containing the names of the economies which are part of the economic system
JLLinputs Set of necessary inputs used in the estimation of the JLL-based models (see "JLL" function)
GVARinputs Set of necessary inputs used in the estimation of the GVAR-based models (see "GVAR" function)
nargout   if nargout < 1, returns only the values of the likelihood function.
          If nargout < 2, generates the entire set of outputs

References

This function is modified version of the "f_with_vectorized_parameters" function by Le and Singleton (2018).
**GaussianDensity**

computes the density function of a gaussian process

**Description**

computes the density function of a gaussian process

**Usage**

GaussianDensity(res, SS, invSS, logabsdetSS)

**Arguments**

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>res</td>
<td>matrix of residuals (N x T)</td>
</tr>
<tr>
<td>SS</td>
<td>covariance matrix or array of covariance matrices (If dim(SS) &gt; 3, then the model has a stochastic volatility) (N x N) or (N x N x T)</td>
</tr>
<tr>
<td>invSS</td>
<td>Inverse of SS (N x N) or (N x N x T) - optional input</td>
</tr>
<tr>
<td>logabsdetSS</td>
<td>log(abs(</td>
</tr>
</tbody>
</table>

**Value**

y - vector of density (1 x T)

**References**

This function is based on the "Gaussian" function by Le and Singleton (2018).

---

**getpara**

Extract the parameter values from varargin

**Description**

Extract the parameter values from varargin

**Usage**

getpara(varargin)

**Arguments**

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>varargin</td>
<td>All parameter features</td>
</tr>
</tbody>
</table>
References

This function is modified version of the "getpara" function by Le and Singleton (2018). "A Small Package of Matlab Routines for the Estimation of Some Term Structure Models." (Euro Area Business Cycle Network Training School - Term Structure Modelling). Available at: https://cepr.org/40029

getx

Obtain the auxiliary values corresponding to each parameter, its size and its name

Description

Obtain the auxiliary values corresponding to each parameter, its size and its name

Usage

getx(con, varargin, Economies, FactorLabels, JLLinputs = NULL)

Arguments

con

If con = 'concentration' and a parameter's name contains '@', then its auxiliary value is set to empty

varargin

variable inputs used in the optimization (see "optimization" function)

Economies

string-vector containing the names of the economies which are part of the economic system

FactorLabels

list of necessary inputs for the estimation of JLL-based models (see "JLL" function)

JLLinputs

Necessary inputs for the estimation of the JLL-based models

References

GFEVDgraphsJLLOrtho  
*GFEVDs graphs for orthogonalized risk factors of JLL-based models*

**Description**

GFEVDs graphs for orthogonalized risk factors of JLL-based models

**Usage**

```
GFEVDgraphsJLLOrtho(
    ModelType,
    NumOut,
    WishPdynamicsgraphs,  
    WishYieldsgraphs,  
    GFEVDhoriz,
    PathsGraphs
)
```

**Arguments**

- **ModelType**: a string-vector containing the label of the model to be estimated
- **NumOut**: list of computed outputs containing the model fit, IRFs, FEVDs, GIRFs, and GFEVDs
- **WishPdynamicsgraphs**: binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise
- **WishYieldsgraphs**: binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise
- **GFEVDhoriz**: single numerical vector containing the desired horizon of analysis for the GFEVDs
- **PathsGraphs**: Path of the folder in which the graphs will be saved

GFEVDgraphsJoint  
*GFEVDs graphs for ("joint Q" models)*

**Description**

GFEVDs graphs for ("joint Q" models)
**Usage**

GFEVDgraphsSep(
    ModelType,
    NumOut,
    WishPdynamicsgraphs,
    WishYieldsgraphs,
    GFEVDhoriz,
    PathsGraphs
)

**Arguments**

- **ModelType**
  - a string-vector containing the label of the model to be estimated

- **NumOut**
  - list of computed outputs containing the model fit, IRFs, FEVDs, GIRFs, and GFEVDs

- **WishPdynamicsgraphs**
  - binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise

- **WishYieldsgraphs**
  - binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise

- **GFEVDhoriz**
  - single numerical vector containing the desired horizon of analysis for the GFEVDs

- **PathsGraphs**
  - Path of the folder in which the graphs will be saved

---

**Description**

GFEVDs graphs for ("sep Q" models)

**Usage**

GFEVDgraphsSep(
    ModelType,
    NumOut,
    WishPdynamicsgraphs,
    WishYieldsgraphs,
    GFEVDhoriz,
    PathsGraphs,
    Economies
)
Arguments

ModelType  a string-vector containing the label of the model to be estimated
NumOut    list of computed outputs containing the model fit, IRFs, FEVDs, GIRFs, and GFEVDs
WishPdynamicsgraphs binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise
WishYieldsgraphs binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise
GFEVDboriz single numerical vector containing the desired horizon of analysis for the GFEVDs
PathsGraphs Path of the folder in which the graphs will be saved
Economies a string-vector containing the names of the economies which are part of the economic system

GFEVDjoint  GFEVDs for "joint Q" models

Description

GFEVDs for "joint Q" models

Usage

GFEVDjoint(ModelType, ModelPara, GFEVDboriz, FactorLabels, Economies)

Arguments

ModelType  string-vector containing the label of the model to be estimated
ModelPara list of model parameter estimates (see the "Optimization" function)
GFEVDboriz single numerical vector containing the desired horizon of analysis for the GFEVDs
FactorLabels string-list based which contains all the labels of all the variables present in the model
Economies  string-vector containing the names of the economies which are part of the economic system

References

• This function is a modified and extended version of the "fevd" function from Smith, L.V. and A. Galesi (2014). GVAR Toolbox 2.0, available at https://sites.google.com/site/gvarmodelling/gvar-toolbox.
**GFEVDjointOrthoJLL**

*Orthogonalized GFEVDs for JLL models*

**Description**

Orthogonalized GFEVDs for JLL models

**Usage**

GFEVDjointOrthoJLL(ModelType, ModelPara, GFEVDhoriz, FactorLabels, Economies)

**Arguments**

- **ModelType**: a string-vector containing the label of the model to be estimated
- **ModelPara**: List of model parameter estimates (See the "Optimization" function)
- **GFEVDhoriz**: single numerical vector containing the desired horizon of analysis for the GFEVDs
- **FactorLabels**: a string-list based which contains all the labels of all the variables present in the model
- **Economies**: a string-vector containing the names of the economies which are part of the economic system

**References**

- This function is a modified and extended version of the "fevd" function from Smith, L.V. and A. Galesi (2014). GVAR Toolbox 2.0, available at https://sites.google.com/site/gvarmodelling/gvar-toolbox.

**GFEVDjointOrthoJLL_BS**

*GFEVDs after bootstrap for JLL-based models*

**Description**

GFEVDs after bootstrap for JLL-based models

**Usage**

GFEVDjointOrthoJLL_BS(
    ModelType,
    ModelParaBoot,
    GFEVDhoriz,
    FactorLabels,
    Economies
)
Arguments

ModelType: string-vector containing the label of the model to be estimated
ModelParaBoot: list of model parameter estimates (see the "Optimization" function) after a bootstrap draw
GFEVDhoriz: single numerical vector containing the desired horizon of analysis for the GFEVDs
FactorLabels: string-list based which contains all the labels of all the variables present in the model
Economies: string-vector containing the names of the economies which are part of the economic system

References

- This function is a modified and extended version of the "fevd" function from Smith, L.V. and A. Galesi (2014). GVAR Toolbox 2.0, available at https://sites.google.com/site/gvarmodelling/gvar-toolbox.

---

GFEVDjoint_BS  GFEVDs after bootstrap for "joint Q" models

Description

GFEVDs after bootstrap for "joint Q" models

Usage

GFEVDjoint_BS(ModelType, ModelParaBoot, GFEVDhoriz, FactorLabels, Economies)

Arguments

ModelType: string-vector containing the label of the model to be estimated
ModelParaBoot: List of model parameter estimates (See the "Optimization" function) after a bootstrap draw
GFEVDhoriz: single numerical vector containing the desired horizon of analysis for the GFEVDs
FactorLabels: string-list based which contains all the labels of all the variables present in the model
Economies: string-vector containing the names of the economies which are part of the economic system
References

- This function is a modified and extended version of the "fevd" function from Smith, L.V. and A. Galesi (2014). GVAR Toolbox 2.0, available at https://sites.google.com/site/gvarmodelling/gvar-toolbox.

GFEVDbsep

**GFEVDs for "sep Q" models**

**Description**

GFEVDs for "sep Q" models

**Usage**

GFEVDbsep(ModelType, ModelPara, GFEVDhoriz, FactorLabels, Economies)

**Arguments**

- **ModelType**: string-vector containing the label of the model to be estimated
- **ModelPara**: list of model parameter estimates (see the "Optimization" function)
- **GFEVDhoriz**: single numerical vector containing the desired horizon of analysis for the GFEVDs
- **FactorLabels**: string-list based which contains all the labels of all the variables present in the model
- **Economies**: string-vector containing the names of the economies which are part of the economic system

**References**

- This function is a modified and extended version of the "fevd" function from Smith, L.V. and A. Galesi (2014). GVAR Toolbox 2.0, available at https://sites.google.com/site/gvarmodelling/gvar-toolbox.
**GFEVDsep_BS**

*GFEVDs after bootstrap for "sep Q" models*

**Description**

GFEVDs after bootstrap for "sep Q" models

**Usage**

GFEVDsep_BS(ModelType, ModelParaBoot, GFEVDhoriz, FactorLabels, Economies)

**Arguments**

- **ModelType** string-vector containing the label of the model to be estimated
- **ModelParaBoot** list of model parameter estimates (see the "Optimization" function) after a bootstrap draw
- **GFEVDhoriz** single numerical vector containing the desired horizon of analysis for the GFEVDs
- **FactorLabels** string-list based which contains all the labels of all the variables present in the model
- **Economies** string-vector containing the names of the economies which are part of the economic system

**References**

- This function is a modified and extended version of the "fevd" function from Smith, L.V. and A. Galesi (2014). GVAR Toolbox 2.0, available at https://sites.google.com/site/gvarmodelling/gvar-toolbox.

**GIRFgraphsJLLOrtho**

*GIRFs graphs for orthogonalized risk factors of JLL-based models*

**Description**

GIRFs graphs for orthogonalized risk factors of JLL-based models

**Usage**

GIRFgraphsJLLOrtho(
    ModelType,
    NumOut,
    WishPdynamicsgraphs,
    WishYieldsgraphs,
    GIRFhoriz,
    Pathgraphs
)
GIRFgraphsJoint

Arguments

- **ModelType**
  - a string-vector containing the label of the model to be estimated
- **NumOut**
  - list of computed outputs containing the model fit, IRFs, FEVDs, GIRFs, and GFEVDs
- **WishPdynamicsgraphs**
  - binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise
- **WishYieldsgraphs**
  - binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise
- **GIRFhoriz**
  - single numerical vector containing the desired horizon of analysis for the GIRFs
- **PathsGraphs**
  - Path of the folder in which the graphs will be saved

Description

GIRFs graphs for ("joint Q" models)

Usage

GIRFgraphsJoint(
  ModelType,
  NumOut,
  WishPdynamicsgraphs,
  WishYieldsgraphs,
  GIRFhoriz,
  PathsGraphs
)

Arguments

- **ModelType**
  - a string-vector containing the label of the model to be estimated
- **NumOut**
  - list of computed outputs containing the model fit, IRFs, FEVDs, GIRFs, and GFEVDs
- **WishPdynamicsgraphs**
  - binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise
- **WishYieldsgraphs**
  - binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise
- **GIRFhoriz**
  - single numerical vector containing the desired horizon of analysis for the GIRFs
- **PathsGraphs**
  - Path of the folder in which the graphs will be saved
GIRFgraphsSep

GIRFs graphs for ("sep Q" models)

Description

GIRFs graphs for ("sep Q" models)

Usage

GIRFgraphsSep(
  ModelType,
  NumOut,
  WishPdynamicsgraphs,
  WishYieldsgraphs,
  GIRFhoriz,
  PathsGraphs,
  Economies
)

Arguments

ModelType a string-vector containing the label of the model to be estimated
NumOut list of computed outputs containing the model fit, IRFs, FEVDs, GIRFs, and GFEVDs
WishPdynamicsgraphs binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise
WishYieldsgraphs binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise
GIRFhoriz single numerical vector containing the desired horizon of analysis for the GIRFs
PathsGraphs Path of the folder in which the graphs will be saved
Economies a string-vector containing the names of the economies which are part of the economic system

GIRFjoint

GIRFs for "joint Q" models

Description

GIRFs for "joint Q" models

Usage

GIRFjoint(ModelType, ModelPara, GIRFhoriz, FactorLabels, Economies)
**GIRFjointOrthoJLL**

**Arguments**

- **ModelType**  
  a string-vector containing the label of the model to be estimated

- **ModelPara**  
  List of model parameter estimates (See the "Optimization" function)

- **GIRFhoriz**  
  single numerical vector containing the desired horizon of analysis for the GIRFs

- **FactorLabels**  
  a string-list based which contains all the labels of all the variables present in the model

- **Economies**  
  a string-vector containing the names of the economies which are part of the economic system

**References**

- This function is a modified and extended version of the "irf" function from Smith, L.V. and A. Galesi (2014). GVAR Toolbox 2.0, available at https://sites.google.com/site/gvarmodelling/gvar-toolbox.


---

**GIRFjointOrthoJLL**  
*Orthogonalized GIRFs for JLL models*

**Description**

Orthogonalized GIRFs for JLL models

**Usage**

GIRFjointOrthoJLL(ModelType, ModelPara, GIRFhoriz, FactorLabels, Economies)

**Arguments**

- **ModelType**  
  a string-vector containing the label of the model to be estimated

- **ModelPara**  
  List of model parameter estimates (See the "Optimization" function)

- **GIRFhoriz**  
  single numerical vector containing the desired horizon of analysis for the GIRFs

- **FactorLabels**  
  a string-list based which contains all the labels of all the variables present in the model

- **Economies**  
  a string-vector containing the names of the economies which are part of the economic system

**References**

- This function is a modified and extended version of the "irf" function from Smith, L.V. and A. Galesi (2014). GVAR Toolbox 2.0, available at https://sites.google.com/site/gvarmodelling/gvar-toolbox.

GIRFjointOrthoJLL_BS  

**GIRFs after bootstrap for JLL-based models**

**Description**

GIRFs after bootstrap for JLL-based models

**Usage**

GIRFjointOrthoJLL_BS(
  ModelType,
  ModelParaBoot,
  GIRFhoriz,
  FactorLabels,
  Economies
)

**Arguments**

- **ModelType**: string-vector containing the label of the model to be estimated
- **ModelParaBoot**: list of model parameter estimates (see the "Optimization" function) after a bootstrap draw
- **GIRFhoriz**: single numerical vector containing the desired horizon of analysis for the GIRFs
- **FactorLabels**: string-list based which contains the labels of all the variables present in the model
- **Economies**: string-vector containing the names of the economies which are part of the economic system

**References**

- This function is a modified and extended version of the "irf" function from Smith, L.V. and A. Galesi (2014). GVAR Toolbox 2.0, available at https://sites.google.com/site/gvarmodelling/gvar-toolbox.

Description

GIRFs after bootstrap for "joint Q" models

Usage

GIRFjoint_BS(ModelType, ModelParaBoot, GIRFhoriz, FactorLabels, Economies)

Arguments

- **ModelType**: string-vector containing the label of the model to be estimated
- **ModelParaBoot**: list of model parameter estimates (see the "Optimization" function) after a bootstrap draw
- **GIRFhoriz**: single numerical vector containing the desired horizon of analysis for the GIRFs
- **FactorLabels**: string-list based which contains all the labels of all the variables present in the model
- **Economies**: string-vector containing the names of the economies which are part of the economic system

References

- This function is a modified and extended version of the "irf" function from Smith, L.V. and A. Galesi (2014). GVAR Toolbox 2.0, available at https://sites.google.com/site/gvarmodelling/gvar-toolbox.

Description

GIRFs for "sep Q" models

Usage

GIRFSep(ModelType, ModelPara, GIRFhoriz, FactorLabels, Economies)
Arguments

- **ModelType**: string-vector containing the label of the model to be estimated
- **ModelParaBoot**: list of model parameter estimates (see the "Optimization" function) after a bootstrap draw
- **GIRFhoriz**: single numerical vector containing the desired horizon of analysis for the GIRFs
- **FactorLabels**: string-list based which contains all the labels of all the variables present in the model
- **Economies**: string-vector containing the names of the economies which are part of the economic system

References

- This function is a modified and extended version of the "irf" function from Smith, L.V. and A. Galesi (2014). GVAR Toolbox 2.0, available at https://sites.google.com/site/gvarmodelling/gvar-toolbox.
GraphicalOutputs  

Generate the graphical outputs for the selected models (Point estimate)

Description

Generate the graphical outputs for the selected models (Point estimate)

Usage

GraphicalOutputs(
    ModelType,
    ModelPara,
    NumOut,
    InputsForOutputs,
    Economies,
    FactorLabels
)

Arguments

ModelType  a string-vector containing the label of the model to be estimated
ModelPara  List of model parameter estimates (See the "Optimization" function)
NumOut  list of computed outputs containing the model fit, IRFs, FEVDs, GIRFs, and GFEVDs
InputsForOutputs  list containing the desired inputs for the construction of the desired output
Economies  string-vector containing the names of the economies which are part of the economic system
FactorLabels  string-list based which contains the labels of all the variables present in the model

GVAR  

Estimate a GVAR(1) and a VARX(1,1,1)

Description

Estimate a GVAR(1) and a VARX(1,1,1)

Usage

GVAR(GVARinputs, N)
Arguments

GVARinputs

List containing the following necessary inputs for the estimation of the GVAR:

1. Economies: string-vector containing the names of the economies which are part of the economic system
2. 'GVARFactors': list of all variables that are used in the estimation of the VARX
   (see e.g. 'CM_Factors_GVAR’ file);
3. 'VARXtype': character-vector containing two possibilities:
   • 'unconstrained': model is estimated without any constrained (each equation is estimated individually by OLS);
   • 'constrained: Spanned Factors': model is estimated taking into account the fact that foreign-pricing-factors do NOT impinge on (i) domestic economic variables and (ii) domestic pricing factors. (equations are estimated by restricted least squares)
   • 'constrained: ' extended by the name of the risk factor: model is estimated taking into account the fact that the restricted factor is only affected by its own lagged values and the lagged values of its own star variables. (equations are estimated by restricted least squares)
4. 'Wgvar': GVAR transition matrix (C x C) - see the output from 'Transition_Matrix’ function

N

number of country-specific spanned factors (scalar)

Value

A list containing

1. parameters of the country-specific VARX(1,1,1)
   • intercept (M+Nx1);
   • phi_1 (M+N x M+N);
   • phi_1^star (M+N x M+N);
   • phi_g (M+N x M+N);
   • Sigma (M+N x G)
2. parameters of the GVAR.
   • F0 (F x 1);
   • F1 (F x F);
   • Sigma_y (F x F)

References

Examples

data(CM_Factors_GVAR)

N <- 3

GVARinputs <- list()
GVARinputs$Economies <- c("China", "Brazil", "Mexico", "Uruguay")
GVARinputs$GVARFactors <- FactorsGVAR
GVARinputs$VARXtype <- "unconstrained"
GVARinputs$Wgvar <- matrix( c(0, 0.83, 0.86, 0.38,
                                0.65, 0, 0.13, 0.55,
                                0.32, 0.12, 0, 0.07,
                                0.03, 0.05, 0.01, 0), nrow = 4, ncol = 4)

GVAR(GVARinputs, N)

IdxAllSpanned

Find the indexes of the spanned factors

Description

Find the indexes of the spanned factors

Usage

IdxAllSpanned(ModelType, FactorLabels, Economies)

Arguments

ModelType string-vector containing the label of the model to be estimated
FactorLabels string-list based which contains the labels of all the variables present in the model
Economies string-vector containing the names of the economies which are part of the economic system

IdxSpanned

Extract the indexes related to the spanned factors in the variance-covariance matrix

Description

Extract the indexes related to the spanned factors in the variance-covariance matrix

Usage

IdxSpanned(G, M, N, C)
InputsForMLEdensity

Arguments

G number of global unspanned factors (scalar)
M number of domestic unspanned factors per country (scalar)
N number of domestic spanned factors per country (scalar)
C number of countries of the economic system (scalar)

Generates several inputs that are necessary to build the likelihood function

Usage

InputsForMLEdensity(
  ModelType,
  Yields,
  PdynamicsFactors,
  FactorLabels,
  mat,
  Economies,
  DataFrequency,
  JLLinputs = NULL,
  GVARinputs = NULL
)

Arguments

ModelType string-vector containing the label of the model to be estimated
Yields time series of yields (JxT or CJ x T)
PdynamicsFactors time series of the risk factors (K x T)
FactorLabels string-list based which contains the labels of all the variables present in the model
mat vector of maturities (in years) used in the estimation
Economies string-vector containing the names of the economies of the system.
InputsForMLEDensity

**JLLinputs**  list of necessary inputs for the estimation of JLL-based models (see "JLL" function)

**GVARinputs**  list of necessary inputs for the estimation of GVAR-based models (see "GVAR" function)

**Details**

To ensure that the risk factors matrix is correctly built for the model "JPS", the global factors should be allocated on the first G rows of this matrix.

**Value**

List of necessary inputs for constructing the model’s log-likelihood function

**Examples**

```
# Example 1:
data(CM_Factors)
data(CM_Yields)

ModelType <- "JPS"
Economies <- "Mexico"
Factors <- RiskFactors
N <- 3
GlobalVar <- c("GBC", "CPI_OECD")  # Global Variables
DomVar <- c("Eco_Act", "Inflation")  # Domestic Variables
FactorLabels <- LabFac(N, DomVar, GlobalVar, Economies, ModelType)

mat <- c(0.25, 0.5, 1, 3, 5, 10)
DataFrequency <- "Monthly"

i <- length(Economies)
ATSMInputs <- InputsForMLEdensity(ModelType, Yields, Factors, FactorLabels, mat,
                                   Economies, DataFrequency)

# Example 2:
data(CM_Factors)
data(CM_Yields)
data(CM_Factors_GVAR)

ModelType <- "GVAR jointQ"
Economies <- c("China", "Brazil", "Mexico", "Uruguay")
mat <- c(0.25, 0.5, 1, 3, 5, 10)
DataFrequency <- "Monthly"
Factors <- RiskFactors
N <- 3
GlobalVar <- c("GBC", "CPI_OECD")  # Global Variables
DomVar <- c("Eco_Act", "Inflation")  # Domestic Variables
FactorLabels <- LabFac(N, DomVar, GlobalVar, Economies, ModelType)

GVARinputs <- list()
GVARinputs$Economies <- Economies
```
GVARinputs$GVARFactors <- FactorsGVAR
GVARinputs$VARXtype <- "unconstrained"
GVARinputs$Wgvar <- matrix(c(0, 0.83, 0.86, 0.38,
          0.65, 0, 0.13, 0.55,
          0.32, 0.12, 0, 0.07,
          0.03, 0.05, 0.01, 0), nrow = 4, ncol = 4)
ATSMInputs <- InputsForMLEdensity(ModelType, Yields, Factors, FactorLabels, mat, Economies,
                                    DataFrequency, JLLinputs= NULL , GVARinputs)

# Example 3:
if (requireNamespace("neldermead", quietly = TRUE)) {
  data(CM_Factors)
data(CM_Yields)
ModelType <- "JLL jointSigma"
GlobalVar <- c("GBC", "CPI_OECD") # Global Variables
DomVar <- c("Eco_Act", "Inflation") # Domestic Variables
N <- 3
Economies <- c("China", "Brazil", "Mexico", "Uruguay")
FactorLabels <- LabFac(N, DomVar, GlobalVar, Economies, ModelType)
Factors <- RiskFactors
mat <- c(0.25, 0.5, 1, 3, 5, 10)
DataFrequency <- "Monthly"
JLLinputs <- list()
JLLinputs$Economies <- Economies
JLLinputs$DomUnit <- "China"
JLLinputs$WishSigmas <- 1
JLLinputs$SigmaNonOrtho <- NULL
JLLinputs$JLLModelType <- ModelType
ATSMInputs <- InputsForMLEdensity(ModelType, Yields, Factors, FactorLabels, mat, Economies,
                                    DataFrequency, JLLinputs)
} else {
  message("skipping functionality due to missing Suggested dependency")
}

---

**InputsForMLEdensity**

Generates several inputs that are necessary to build the likelihood function - Bootstrap version

**Description**

Generates several inputs that are necessary to build the likelihood function - Bootstrap version
Usage

InputsForMLEdensity_BS(
  ModelType,
  Y_artificial,
  Z_artificial,
  FactorLabels,
  mat,
  Economies,
  DataFrequency,
  JLLinputs = NULL,
  GVARinputs = NULL
)

Arguments

ModelType string-vector containing the label of the model to be estimated
Y_artificial time series of yields (CJ x T or JxT)
Z_artificial time series of the risk factors (F x T)
FactorLabels string-list based which contains the labels of all the variables present in the model
mat vector of maturities (in years) used in the estimation
Economies string-vector containing the names of the economies of the system.
  If the ModelType selected is "JPS", "JPS jointP", "GVAR sepQ", then only one economy can be selected.
  For the other models, more than one economy must be selected.
JLLinputs list of necessary inputs for the estimation of JLL-based models (see "JLL" function)
GVARinputs list of necessary inputs for the estimation of GVAR-based models (see "GVAR" function)

InputsForOutputs Collect the inputs that are used to construct the numerical and the graphical outputs

Description

Collect the inputs that are used to construct the numerical and the graphical outputs
Usage

InputsForOutputs(
  ModelType,
  Horiz,
  ListOutputWished,
  OutputLabel,
  WishStationarityQ,
  WishGraphYields = 0,
  WishGraphRiskFactors = 0,
  WishOrthoJLLgraphs = 0,
  WishBootstrap = 0,
  ListBoot = NULL,
  WishForecast = 0,
  ListForecast = NULL
)

Arguments

ModelType      String-vector containing the label of the model to be estimated
Horiz          Single numerical vector containing the desired horizon of analysis for the outputs
ListOutputWished List of desired graphical outputs. Available options are: "Fit","IRF", "FEVD", "GIRF", "GFEVD".
OutputLabel    Name of the output label to be stored
WishStationarityQ User must set 1 if she wishes to impose the largest eigenvalue under the Q to be strictly smaller than 1, otherwise set 0.
WishGraphYields Binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise. Default is set as "0".
WishGraphRiskFactors Binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise. Default is set as "0".
WishOrthoJLLgraphs Binary variable: set 1, if the user wishes orthogonalized JLL-based graphs to be generated; or set 0, otherwise. Default is set as "0".
WishBootstrap   Binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise. Default is set as "0".
ListBoot        List containing the four following elements:
  1. "methodBS": Desired bootstrap method among (a) 'bs' (standard residual bootstrap), (b) 'wild' (wild bootstrap), (c) 'block' (block bootstrap);
  2. "BlockLength": if block bootstrap is chosen, then the user has to specify the length of the block (single numerical vector);
  3. "ndraws": number of draws;
4. "pctg": level of confidence (single numerical vector expressed in basis points)

WishForecast  Binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise. Default is set as "0".

ListForecast  list containing the three following elements:
1. "ForHoriz": forecast horizon;
2. "t0Sample": index of the first variable of the information set;
3. "t0Forecast": index of the first forecast cut-off date.

Value
List of necessary inputs to generate the graphs of the outputs of the desired model

Examples

```r
ModelType <- "JPS"
Horiz <- 100
DesiredOutputGraphs <- c("Fit", "GIRF", "GFEVD")
OutputLabel <- "Test"
WishStationarityQ <- 1
WishGraphRiskFac <- 0
WishGraphYields <- 1

InputsList <- InputsForOutputs(ModelType, Horiz, DesiredOutputGraphs, OutputLabel,
                                WishStationarityQ, WishGraphYields, WishGraphRiskFac)
```

```
IRFandGIRFbs_jointQ
Creates the confidence bounds and the graphs of IRFs and GIRFs after bootstrap ("joint Q" models)
```

Description

Creates the confidence bounds and the graphs of IRFs and GIRFs after bootstrap ("joint Q" models)

Usage

```r
IRFandGIRFbs_jointQ(
    ModelType, 
    ModelBootstrap, 
    NumOutPE, 
    InputsForOutputs, 
    Economies, 
    PathsGraphs 
)
```
**Arguments**

- **ModelType**  
  string-vector containing the label of the model to be estimated

- **ModelBootstrap**  
  list containing the complete set of model parameters after bootstrap estimation procedure

- **NumOutPE**  
  list of model parameter point estimates

- **InputsForOutputs**  
  list containing the desired inputs for the construction of the outputs of interest

- **Economies**  
  string-vector containing the names of the economies which are part of the economic system

- **PathsGraphs**  
  path of the folder in which the graphs will be saved

---

**IRFandGIRFs_jointQ_Ortho**

*Creates the confidence bounds and the graphs of IRFs and GIRFs after bootstrap (JLL-based models)*

---

**Description**

Creates the confidence bounds and the graphs of IRFs and GIRFs after bootstrap (JLL-based models)

**Usage**

```
IRFandGIRFs_jointQ_Ortho(
    ModelType,  
    ModelBootstrap,  
    NumOutPE,  
    InputsForOutputs,  
    Economies,  
    PathsGraphs
)
```

**Arguments**

- **ModelType**  
  string-vector containing the label of the model to be estimated

- **ModelBootstrap**  
  list containing the complete set of model parameters after bootstrap estimation procedure

- **NumOutPE**  
  list of model parameter point estimates

- **InputsForOutputs**  
  list containing the desired inputs for the construction of the outputs of interest

- **Economies**  
  string-vector containing the names of the economies which are part of the economic system

- **PathsGraphs**  
  path of the folder in which the graphs will be saved
Description

Creates the confidence bounds and the graphs of IRFs and GIRFs after bootstrap ("sep Q" models)

Usage

IRFandGIRFbs_sepQ(
  ModelType,
  ModelBootstrap,
  NumOutPE,
  InputsForOutputs,
  Economies,
  PathsGraphs
)

Arguments

ModelType string-vector containing the label of the model to be estimated
ModelBootstrap list containing the complete set of model parameters after bootstrap estimation procedure
NumOutPE list of model parameter point estimates
InputsForOutputs list containing the desired inputs for the construction of the outputs of interest
Economies string-vector containing the names of the economies which are part of the economic system
PathsGraphs path of the folder in which the graphs will be saved

Description

IRFs graphs for orthogonalized risk factors of JLL-based models

IRFgraphsJLLOrtho IRFs graphs for orthogonalized risk factors of JLL-based models
Usage

IRFgraphsJLLOrtho(  
ModelType,  
NumOut,  
WishPdynamicsgraphs,  
WishYieldsgraphs,  
IRFhoriz,  
PathsGraphs  
)

Arguments

ModelType a string-vector containing the label of the model to be estimated
NumOut list of computed outputs containing the model fit, IRFs, FEVDs, GIRFs, and GFEVDs
WishPdynamicsgraphs binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise
WishYieldsgraphs binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise
IRFhoriz single numerical vector containing the desired horizon of analysis for the IRFs
PathsGraphs Path of the folder in which the graphs will be saved

Description

IRFs graphs for ("joint Q" models)

Usage

IRFgraphsJoint(  
ModelType,  
NumOut,  
WishPdynamicsgraphs,  
WishYieldsgraphs,  
IRFhoriz,  
PathsGraphs  
)
IRFgraphsSep

Arguments

- **ModelType**
  a string-vector containing the label of the model to be estimated

- **NumOut**
  list of computed outputs containing the model fit, IRFs, FEVDs, GIRFs, and GFEVDs

- **WishPdynamicsgraphs**
  binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise

- **WishYieldsgraphs**
  binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise

- **IRFhoriz**
  single numerical vector containing the desired horizon of analysis for the IRFs

- **PathsGraphs**
  Path of the folder in which the graphs will be saved

- **Economies**
  a string-vector containing the names of the economies which are part of the economic system

Description

IRFs graphs for ("sep Q" models)

Usage

IRFgraphsSep(
  ModelType,
  NumOut,
  WishPdynamicsgraphs,
  WishYieldsgraphs,
  IRFhoriz,
  PathsGraphs,
  Economies
)

Arguments

- **ModelType**
  a string-vector containing the label of the model to be estimated

- **NumOut**
  list of computed outputs containing the model fit, IRFs, FEVDs, GIRFs, and GFEVDs

- **WishPdynamicsgraphs**
  binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise

- **WishYieldsgraphs**
  binary variable: set 1, if the user wishes graphs to be generated; or set 0, otherwise

- **IRFhoriz**
  single numerical vector containing the desired horizon of analysis for the IRFs

- **PathsGraphs**
  Path of the folder in which the graphs will be saved

- **Economies**
  a string-vector containing the names of the economies which are part of the economic system
IRFjoint

**IRFs for "joint Q" models**

**Description**
IRFs for "joint Q" models

**Usage**
IRFjoint(ModelType, ModelPara, IRFhoriz, FactorLabels, Economies)

**Arguments**
- **ModelType** string-vector containing the label of the model to be estimated
- **ModelPara** list of model parameter estimates (see the "Optimization" function)
- **IRFhoriz** single numerical vector containing the desired horizon of analysis for the IRFs
- **FactorLabels** string-list based which contains all the labels of all the variables present in the model
- **Economies** string-vector containing the names of the economies which are part of the economic system

**Details**
Structural shocks are identified via Cholesky decomposition

IRFjointOrthoJLL

**Orthogonalized IRFs for JLL models**

**Description**
Orthogonalized IRFs for JLL models

**Usage**
IRFjointOrthoJLL(ModelType, ModelPara, IRFhoriz, FactorLabels, Economies)

**Arguments**
- **ModelType** string-vector containing the label of the model to be estimated
- **ModelPara** list of model parameter estimates (see the "Optimization" function)
- **IRFhoriz** single numerical vector containing the desired horizon of analysis for the IRFs
- **FactorLabels** string-list based which contains all the labels of all the variables present in the model
- **Economies** string-vector containing the names of the economies which are part of the economic system
Details
Structural shocks are identified via Cholesky decomposition

IRFjointOrthoJLL_BS  IRFs after bootstrap for JLL-based models

Description
IRFs after bootstrap for JLL-based models

Usage
IRFjointOrthoJLL_BS(
ModelType,  
ModelParaBoot,  
IRFhoriz,  
FactorLabels,  
Economies  
)

Arguments
ModelType     string-vector containing the label of the model to be estimated  
ModelParaBoot list of model parameter estimates (see the "Optimization" function) after a bootstrap draw  
IRFhoriz      single numerical vector containing the desired horizon of analysis for the IRFs  
FactorLabels  string-list based which contains all the labels of all the variables present in the model  
Economies     string-vector containing the names of the economies which are part of the economic system

IRFjoint_BS  IRFs after bootstrap for "joint Q" models

Description
IRFs after bootstrap for "joint Q" models

Usage
IRFjoint_BS(ModelType, ModelParaBoot, IRFhoriz, FactorLabels, Economies)
Arguments

ModelType  string-vector containing the label of the model to be estimated
ModelParaBoot  list of model parameter estimates (see the "Optimization" function) after a bootstrap draw
IRFhoriz  single numerical vector containing the desired horizon of analysis for the IRFs
FactorLabels  a string-list based which contains all the labels of all the variables present in the model
Economies  a string-vector containing the names of the economies which are part of the economic system

Details

Structural shocks are identified via Cholesky decomposition
**IRFsep_BS**

*IRFs after bootstrap for "sep Q" models*

**Description**

IRFs after bootstrap for "sep Q" models

**Usage**

IRFsep_BS(ModelType, ModelParaBoot, IRFhoriz, FactorLabels, Economies)

**Arguments**

- **ModelType**
  string-vector containing the label of the model to be estimated
- **ModelParaBoot**
  list of model parameter estimates (see the "Optimization" function) after a bootstrap draw
- **IRFhoriz**
  single numerical vector containing the desired horizon of analysis for the IRFs
- **FactorLabels**
  string-list based which contains all the labels of all the variables present in the model
- **Economies**
  string-vector containing the names of the economies which are part of the economic system

**JLL**

*Set of inputs present at JLL’s P-dynamics*

**Description**

Set of inputs present at JLL’s P-dynamics

**Usage**

JLL(NonOrthoFactors, N, JLLinputs)

**Arguments**

- **NonOrthoFactors**
  Risk factors before the orthogonalization (FxT)
- **N**
  Number of country-specific spanned factors
- **JLLinputs**
  List of necessary inputs to estimate JLL outputs:
  1. Economies: set of economies that are part of the economic system (string-vector)
  2. "DomUnit": name of the economy which is assigned as the dominant unit. If no dominant unit is assigned, then this variable is defined as "None"
3. WishSigmas: equal to "1" if one wishes the variance-covariance matrices and the Cholesky factorizations (can take long if they need to be estimated). Set "0", otherwise.

4. SigmaNonOrtho: NULL or some K x K matrix from the non-orthogonalized dynamics

5. JLLModelType: available options are "JLL original", "JLL jointSigma" or "JLL NoDomUnit"

Details
For the models 'JLL original' or "JLL jointSigma" the name of one dominant economy must assigned.
For the model 'JLL NoDomUnit', the name of one dominant economy must be set as "None".

Value
List of model parameters from both the orthogonalized and non-orthogonalized versions of the JLL's based models

References

Examples

```r
if (requireNamespace('neldermead', quietly = TRUE)) {
  data(CM_Factors)
  ZZ <- RiskFactors
  N <- 3

  JLLinputs <- list()
  JLLinputs$Economies <- c("China", "Brazil", "Mexico", "Uruguay")
  JLLinputs$DomUnit <- "China"
  JLLinputs$WishSigmas <- 1
  JLLinputs$SigmaNonOrtho <- NULL
  JLLinputs$JLLModelType <- "JLL original"
  JLL(ZZ, N, JLLinputs)
}
```

**K1XQStationary**

*Impose stationarity under the Q-measure*

**Description**

Impose stationarity under the Q-measure

**Usage**

```
K1XQStationary(StationaryEigenvalues)
```

**Arguments**

- **StationaryEigenvalues**
  - Binary variable: set "1" if the user wishes the largest eigenvalue to be strictly smaller than 1. Set "0", otherwise

**Value**

list

**Examples**

```
stat <- 1 # Takes values 1 and 0
K1XQStationary(stat)
```

**killa**

*Eliminates the @*

**Description**

Eliminates the @

**Usage**

```
killa(s)
```

**Arguments**

- **s**
  - text vector containing the feature of the variable

**References**

LabFac

---

**LabelsSpanned**  
*Generate the labels of the spanned factors*

**Description**  
Generate the labels of the spanned factors

**Usage**  
LabelsSpanned(N)

**Arguments**  
- **N**  
  number of spanned factors

---

**LabelsStar**  
*Generate the labels of the star variables*

**Description**  
Generate the labels of the star variables

**Usage**  
LabelsStar(FactorLabels)

**Arguments**  
- **FactorLabels**  
  Factor labels

---

**LabFac**  
*Generates the labels factors*

**Description**  
Generates the labels factors

**Usage**  
LabFac(N, DomVar, GlobalVar, Economies, ModelType)
**Maturities**

**Arguments**

- **N**
  - number of spanned factors per country (scalar)
- **DomVar**
  - character-vector containing the names of the domestic variables
- **GlobalVar**
  - character-vector containing the names of the global variables
- **Economies**
  - string-vector containing the names of the economies which are part of the economic system
- **ModelType**
  - string-vector containing the label of the model to be estimated

**Value**

List containing the country-specific risk factor labels

**Examples**

```r
N <- 2
DomVar <- c("inflation", "Economic growth")
GlobalVar <- "Commodity Prices"
Economies <- c("U.S.", "Canada", "Germany", "Japan")
ModelType <- "JPS"

VarLabels <- LabFac(N, DomVar, GlobalVar, Economies, ModelType)
```

---

**Maturities**

Create a vector of numerical maturities in years

**Description**

Create a vector of numerical maturities in years

**Usage**

`Maturities(DataYields, Economies, UnitYields)`

**Arguments**

- **DataYields**
  - matrix containing all yields of the system (JxT, if the model is single-country-based or CJxT if the model is multi-country-based)
- **Economies**
  - vector containing names of all the economies of the system
- **UnitYields**
  - (i) "Month": if maturity of yields are expressed in months or (ii) "Year": if maturity of yields are expressed in years

**Value**

Vector containing all observed maturities expressed in years
Examples

data('CM_Yields')
Economies <- c("China", "Brazil", "Mexico", "Uruguay")
Maturities(Yields, Economies, "Month")

MLEdensity_jointQ

Compute the maximum likelihood function ("joint Q" models)

Description

Compute the maximum likelihood function ("joint Q" models)

Usage

MLEdensity_jointQ(
    K1XQ,
    r0,
    SSZ,
    K0Z,
    K1Z,
    se,
    Gy.0,
    mat,
    Y,
    Z,
    P,
    Wpca,
    We,
    WpcaFull,
    dt,
    Economies,
    FactorLabels,
    ModelType,
    GVARinputs,
    JLLinputs,
    nargout
)

Arguments

K1XQ       risk-neutral feedback matrix (NxN)
r0         long-run interest rate (scalar)
SSZ        variance-covariance matrix (KxK)
K0Z        intercept from the P-dynamics (Kx1)
K1Z        feedback matrix from the P-dynamics (KxK)
Compute the maximum likelihood function ("joint Q" models for separate Sigma estimation)
Usage

MLEdensity_jointQ_sepSigma(
    K1XQ,
    r0,
    SSZ,
    K0Z,
    K1Z,
    se,
    Gy.0,
    mat,
    Y,
    Z,
    P,
    Wpca,
    We,
    WpcaFull,
    dt,
    Economies,
    FactorLabels,
    ModelType,
    JLLinputs,
    nargout
)

Arguments

K1XQ  risk-neutral feedback matrix (NxN)
r0    long-run interest rate (scalar)
SSZ   variance-covariance matrix (KxK)
K0Z   intercept from the P-dynamics (Kx1)
K1Z   feedback matrix from the P-dynamics (KxK)
se    Variance of the portfolio of yields observed with error (scalar)
Gy.0  matrix of contemporaneous terms from the P-dynamics (KxK)
mat   vector of maturities (in years) of yields used in estimation (J x 1)
Y     matrix of yields used in estimation (J x T)
Z     complete set of spanned and unspanned factors (KxT)
P     complete set of spanned factors (N x T)
Wpca  matrix of weights of the portfolios observed without errors (N x J)
We    matrix of weights of the portfolios observed with errors ((J-N) x J)
WpcaFull composite matrix of weights the portfolios observed with and without errors
dt    time interval unit of the model (scalar). For instance, if data is (i) monthly, dt <- 12; (ii) quarterly, dt <- 4; (iii) yearly, dt <- 1.
Economies  Set of economies that are part of the economic system (vector of text)
FactorLabels   string-list based which contains the labels of all the variables present in the model
ModelType      feasible options are (i) "JLL original" or (ii) "JLL NoDomUnit"
JLLinputs      if the model chosen is the "JLL jointSigma", "JLLinputs" should be specified (see "JLL" function)
nargout        if nargout== 1: provides only the values of the likelihood; if nargout== 2: complete ATSM outputs

References
This function is an extended version of the "A0N_MLEdensity_WOE" function by Le and Singleton (2018).

MLEdensity_sepQ  Compute the maximum likelihood function ("sep Q" models)

Description
Compute the maximum likelihood function ("sep Q" models)

Usage

MLEdensity_sepQ(
    K1XQ,
    r0,
    SSZ,
    K0Z,
    K1Z,
    se,
    Gy.0,
    mat,
    Y,
    Z,
    P,
    Wpca,
    We,
    WpcaFull,
    dt,
    Economy,
    FactorLabels,
    ModelType,
    GVARinputs = NULL,
    nargout
)
Arguments

\( K_{1XQ} \) risk-neutral feedback matrix (NxN)
\( r_0 \) long-run interest rate (scalar)
\( SSZ \) variance-covariance matrix (KxK)
\( K_0 Z \) intercept from the P-dynamics (Kx1)
\( K_{1Z} \) feedback matrix from the P-dynamics (KxK)
\( se \) Variance of the portfolio of yields observed with error (scalar)
\( Gy.0 \) matrix of contemporaneous terms from the P-dynamics (KxK)
\( mat \) vector of maturities (in years) of yields used in estimation (J x 1)
\( Y \) matrix of yields used in estimation (J x T)
\( Z \) complete set of spanned and unspanned factors (KxT)
\( P \) complete set of spanned factors (NxT)
\( W_{pca} \) matrix of weights of the portfolios observed without errors (NxJ)
\( W_{e} \) matrix of weights of the portfolios observed with errors ((J-N)xJ)
\( W_{pcaFull} \) composite matrix of weights the portfolios observed with and without errors
\( dt \) time interval unit of the model (scalar). For instance, if data is (i) monthly, dt <- 12; (ii) quarterly, dt <- 4; (iii) yearly, dt <- 1.

Economy name of the economy under study
FactorLabels string-list based which contains the labels of all the variables present in the model
ModelType Feasible options are: (i) "JPS", (ii) "JPS jointP" or (iii) "GVAR sepQ"
GVARinputs if the model chosen is the "GVAR sepQ", the "GVARinputs" should be specified (see "GVAR" function)
nargout if nargout== 1: provides only the values of the likelihood; if nargout== 2: complete ATSM outputs

References

This function is modified version of the "A0N_MLEdensity_WOE" function by Le and Singleton (2018).
"A Small Package of Matlab Routines for the Estimation of Some Term Structure Models."
(Euro Area Business Cycle Network Training School - Term Structure Modelling). Available at: https://cepr.org/40029
**ModelPara**

*Replications of the JPS (2014) outputs by the MultiATSM package*

**Description**

Unspanned macro risk model outputs by the MultiATSM package

**Usage**

data("JPSrep")

**Format**

list of inputs and outputs

inputs general model inputs
ests model parameters estimates (JPS form)
llk log-likelihood of the observations
rot model parameters estimates (rotation form)

---

**MultiATSM**

*ATSM Package*

**Description**

Estimation of several classes of affine term structure of interest rates models.

**Author(s)**

Rubens Moura <rubens.gtmoura@gmail.com>
Construct the model numerical outputs (model fit, IRFs, GIRFs, FEVDs, and GFEVDs)

**Usage**

```
NumOutputs(ModelType, ModelPara, InputsForOutputs, FactorLabels, Economies)
```

**Arguments**

- **ModelType**: a string-vector containing the label of the model to be estimated
- **ModelPara**: List of model parameter estimates (See the "Optimization" function)
- **InputsForOutputs**: list conataining the desired horizon of analysis for the model fit, IRFs, GIRFs, FEVDs, and GFEVDs
- **FactorLabels**: a string-list based which contains all the labels of all the variables present in the model
- **Economies**: a string-vector containing the names of the economies which are part of the economic system

**Value**

List of the model numerical outputs, namely

1. Model fit of bond yields
2. IRFs
3. FEVDs
4. GIRFs
5. GFEVDs

**Examples**

# See examples in the vignette file of this package (Section 4).
NumOutputs_Bootstrap  

Numerical outputs (IRFs, GIRFs, FEVD, and GFEVD) for bootstrap

Description

Numerical outputs (IRFs, GIRFs, FEVD, and GFEVD) for bootstrap

Usage

NumOutputs_Bootstrap(
    ModelType,  
    ModelParaBoot,  
    InputsForOutputs,  
    FactorLabels,  
    Economies  
)

Arguments

ModelType  string-vector containing the label of the model to be estimated  
ModelParaBoot  list of model parameter estimates (see the "Optimization" function) after a bootstrap draw  
InputsForOutputs  list containing the desired inputs for the construction of the model fit, IRFs, GIRFs, FEVDs, and GFEVDs  
FactorLabels  string-list based which contains all the labels of all the variables present in the model  
Economies  string-vector containing the names of the economies which are part of the economic system

Optimization  

Perform the minimization of mean(f)

Description

Perform the minimization of mean(f)

Usage

Optimization(
    f,  
    tol,  
    varargin,  
    FactorLabels,
Economies,
ModelType,
JLLinputs = NULL,
GVARinputs = NULL
)

Arguments

f   vector-valued objective function (function)
tol convergence tolerance (scalar). For ML estimation, a reasonable value is tol <- 1e-4
vargin list containing starting values and constraints: for each input argument K (of f), we need four inputs that look like:
  1. a starting value: K0
  2. a variable label (‘K0’) followed by a ':' followed by a type of constraint. The constraint can be:
     • 'bounded': bounded matrix;
     • 'Jordan' or 'Jordan MultiCountry': a matrix of Jordan type;
     • 'psd': psd matrix;
     • 'stationary': largest eigenvalue of the risk-neutral feedback matrix is strictly smaller than 1;
     • 'diag' or 'BlockDiag': a diagonal or block diagonal matrix.
     • 'JLLstructure': to impose the zero-restrictions on the variance-covariance matrix along the lines of the JLL models
  3. a lower bound lb (lb <- NULL -> no lower bound)
  4. an upper bound ub (ub <- NULL -> no upper bound)
  5. Specification of the optimization settings:
     • 'iter off': hide the printouts of the numerical optimization routines;
     • 'fminunc only': only uses fminunc for the optimization;
     • 'fminsearch only': only uses fminsearch for the optimization.

FactorLabels string-list based which contains the labels of all the variables present in the model
Economies string-vector containing the names of the economies which are part of the economic system
ModelType string-vector containing the label of the model to be estimated
JLLinputs inputs used in the estimation of the JLL-based models; Default is set to NULL
GVARinputs inputs used in the estimation of the GVAR-based models; Default is set to NULL

Details

If a variable name starts with a '@', it means that that parameter will be analytically concentrated out in the specification of f. In this case, no starting value is needed for this particular parameter (an empty matrix can be provided as a starting value).
**Value**

(i) `out`: list of second output produced by `f` (the first output of `f` must be the objective value to be minimized).
(ii) `x`: list containing parameter estimates

**References**

This function is based on the "LS_opt" function by Le and Singleton (2018). "A Small Package of Matlab Routines for the Estimation of Some Term Structure Models." (Euro Area Business Cycle Network Training School - Term Structure Modelling). Available at: https://cepr.org/40029

**Examples**

```r
# See examples in the vignette file of this package (Section 4).
```

---

**Optimization_Boot**  
*Perform the minimization of mean(f) (adapted for the bootstrap setting)*

**Description**

Perform the minimization of mean(f) (adapted for the bootstrap setting)

**Usage**

```r
Optimization_Boot(
  f,
  tol,
  varargin,
  FactorLabels,
  Economies,
  ModelType,
  JLLinputs = NULL,
  GVARinputs = NULL
)
```

**Arguments**

- `f`: vector-valued objective function (function)
- `tol`: convergence tolerance (scalar). For ML estimation, a reasonable value is `tol <- 1e-4`
- `varargin`: list containing starting values and constraints: for each input argument `K` (of `f`), we need four inputs that look like:
  1. a starting value: `K0`
2. a variable label (‘K0’) followed by a ‘:’ followed by a type of constraint. The constraint can be:
   - ‘bounded’: bounded matrix;
   - ‘Jordan’ or ‘Jordan MultiCountry’: a matrix of Jordan type;
   - ‘psd’: psd matrix;
   - ‘stationary’: largest eigenvalue of the risk-neutral feedback matrix is strictly smaller than 1;
   - ‘diag’ or ‘BlockDiag’: a diagonal or block diagonal matrix.
   - ‘JLLstructure’: to impose the zero-restrictions on the variance-voriance matrix along the lines of the JLL models.
3. a lower bound lb (lb <- NULL -> no lower bound)
4. an upper bound ub (ub <- NULL -> no upper bound)
5. Specification of the optimization settings:
   - ‘iter off’: hide the printouts of the numerical optimization routines;
   - ‘fminunc only’: only uses fminunc for the optimization;
   - ‘fminsearch only’: only uses fminsearch for the optimization.

**FactorLabels**
string-list based which contains the labels of all the variables present in the model.

**Economies**
string-vector containing the names of the economies which are part of the economic system.

**ModelType**
string-vector containing the label of the model to be estimated.

**JLLinputs**
inputs used in the estimation of the JLL-based models; Default is set to NULL.

**GVARinputs**
inputs used in the estimation of the GVAR-based models; Default is set to NULL.

**Details**
If a variable name starts with a ‘@’, it means that that parameter will be analytically concentrated out in the specification of f. In this case, no starting value is needed for this particular parameter. An empty matrix can be provided as a starting value.

**Value**
(i) out: list of second output produced by f (the first output of f must be the objective value to be minimized)
(ii) x: list containing parameter estimates

**References**
This function is based on the "LS__opt" function by Le and Singleton (2018). "A Small Package of Matlab Routines for the Estimation of Some Term Structure Models." (Euro Area Business Cycle Network Training School - Term Structure Modelling). Available at: https://cepr.org/40029
OutputConstructionJoint

Numerical outputs (variance explained, model fit, IRFs, GIRFs, FEVDs, and GFEVDs) for "joint Q" models

Description

Numerical outputs (variance explained, model fit, IRFs, GIRFs, FEVDs, and GFEVDs) for "joint Q" models

Usage

OutputConstructionJoint(
  ModelType,
  ModelPara,
  InputsForOutputs,
  FactorLabels,
  Economies
)

Arguments

ModelType  string-vector containing the label of the model to be estimated
ModelPara  list of model parameter estimates (see the "Optimization" function)
InputsForOutputs  list containing the desired horizon of analysis for the model fit, IRFs, GIRFs, FEVDs, and GFEVDs
FactorLabels  string-list based which contains all the labels of all the variables present in the model
Economies  string-vector containing the names of the economies which are part of the economic system

OutputConstructionJoint_BS

Gathers all the model numerical outputs after bootstrap for "joint Q" models

Description

Gathers all the model numerical outputs after bootstrap for "joint Q" models
OutputConstructionSep

Usage

OutputConstructionJoint_BS(
    ModelType,
    ModelParaBoot,
    InputsForOutputs,
    FactorLabels,
    Economies
)

Arguments

ModelType string-vector containing the label of the model to be estimated
ModelParaBoot list of model parameter estimates (see the "Optimization" function) after a bootstrap draw
InputsForOutputs list containing the desired inputs for the construction of IRFs, GIRFs, FEVDs, and GFEVDs
FactorLabels string-list based which contains all the labels of all the variables present in the model
Economies string-vector containing the names of the economies which are part of the economic system

OutputConstructionSep Numerical outputs (variance explained, model fit, IRFs, GIRFs, FEVDs, and GFEVDs) for "sep Q" models

Description

Numerical outputs (variance explained, model fit, IRFs, GIRFs, FEVDs, and GFEVDs) for "sep Q" models

Usage

OutputConstructionSep(
    ModelType,
    ModelPara,
    InputsForOutputs,
    FactorLabels,
    Economies
)
OutputConstructionSep_BS

Arguments

ModelType : string-vector containing the label of the model to be estimated
ModelParaBoot : list of model parameter estimates (See the "Optimization" function)
InputsForOutputs : list containing the desired horizon of analysis for the model fit, IRFs, GIRFs, FEVDs, and GFEVDs
FactorLabels : string-list based which contains all the labels of all the variables present in the model
Economies : string-vector containing the names of the economies which are part of the economic system

OutputConstructionSep_BS

Gathers all the model numerical outputs after bootstrap for "sep Q" models

Description

Gathers all the model numerical outputs after bootstrap for "sep Q" models

Usage

OutputConstructionSep_BS(
    ModelType,
    ModelParaBoot,
    InputsForOutputs,
    FactorLabels,
    Economies
)

Arguments

ModelType : string-vector containing the label of the model to be estimated
ModelParaBoot : list of model parameter estimates (see the "Optimization" function) after a bootstrap draw
InputsForOutputs : list containing the desired inputs for the construction of the model fit, IRFs, GIRFs, FEVDs, and GFEVDs
FactorLabels : string-list based which contains all the labels of all the variables present in the model
Economies : string-vector containing the names of the economies which are part of the economic system
ParaLabels

*Create the variable labels used in the estimation*

**Description**
Create the variable labels used in the estimation

**Usage**
ParaLabels(ModelType, WishStationarityQ)

**Arguments**
- **ModelType**
  a string-vector containing the label of the model to be estimated
- **WishStationarityQ**
  User must set "1" is she whises to impose the largest eigenvalue under the Q to be strictly smaller than 1. Otherwise set "0"

**Value**
list containing the features of the parameters that will be used in the estimation

**Examples**
```
ModelType <- "GVAR jointQ"
WishStationarityQ <- 1
ParaLabels(ModelType, WishStationarityQ)
```

---

pca_weights_one_country

*Weigth matrix from principal components (matrix of eigenvectors)*

**Description**
Weigth matrix from principal components (matrix of eigenvectors)

**Usage**
pca_weights_one_country(Y, Economy)

**Arguments**
- **Y**
  matrix dimension (J x T), where J - the number of maturities and T - time series length
- **Economy**
  string-vector containg the name of one economy
PdynamicsSet_BS

Value

matrix (J x J)

Examples

data("CM_Yields")
pca_weights_one_country(Yields, Economy= "Brazil")

PdynamicsSet_BS

Compute some key parameters from the P-dynamics (Bootstrap set)

Description

Compute some key parameters from the P-dynamics (Bootstrap set)

Usage

PdynamicsSet_BS(
  ModelType,
  AllFactorsUnderP,
  FactorLabels,
  Economies,
  JLLinputs = NULL,
  GVARinputs = NULL
)

Arguments

ModelType  string-vector containing the label of the model to be estimated
AllFactorsUnderP  complete set of factors that may be used in the estimation of P (KxT)
FactorLabels  string-list based which contains the labels of all the variables present in the model (see "LabFac" function)
Economies  string-vector containing the names of the economies which are part of the economic system
JLLinputs  List containing the necessary inputs for the estimation of the JLL-based models (see "JLL" function). Default is set to NULL.
GVARinputs  List containing the necessary inputs for the estimation of the GVAR-based models (see "GVAR" function). Default is set to NULL.
pos2x

Transform a positive number $y$ to back to $x$ by:

Usage

pos2x($y$)

Arguments

$y$ scalar

References

This function is based on the "pos2x" function by Le and Singleton (2018). "A Small Package of Matlab Routines for the Estimation of Some Term Structure Models." (Euro Area Business Cycle Network Training School - Term Structure Modelling). Available at: https://cepr.org/40029

Reg_K1Q

Estimate the risk-neutral feedback matrix $K_{1Q}$ using linear regressions

Description

Estimate the risk-neutral feedback matrix $K_{1Q}$ using linear regressions

Usage

Reg_K1Q($Y$, mat, $Z$, dt, type)

Arguments

$Y$ matrix of yields used in estimation ($J$ x $T$)

mat vector of maturities (in years) of yields used in estimation ($J$ x 1)

$Z$ pricing factors (can be yields-based or non-yields/macro variables) ($N$ x $T$)

dt time unit of the model (scalar). For instance, if data is (i) monthly, $dt$ <- 12; (ii) quarterly, $dt$ <- 4; (iii) yearly, $dt$ <- 1.

'type' 'Jordan' -> $K_{1Q}$ will be of the Jordan type
Value

Risk neutral feedback matrix K1Q.

References

This function is based on the "Reg_K1Q" function by Le and Singleton (2018). "A Small Package of Matlab Routines for the Estimation of Some Term Structure Models." (Euro Area Business Cycle Network Training School - Term Structure Modelling). Available at: https://cepr.org/40029

Examples

data(CM_Yields)

Y_China <- Yields[1:6,]
Z_China <- Spanned_Factors(Y_China, Economies ="China", N=3)
mat <-c(0.25 , 0.5 , 1, 3, 5, 10)
dt <- 1/12
type <- 'Jordan'
Reg_K1Q(Y_China, mat, Z_China, dt, type)

Description

Restricted OLS regression

Usage

Reg__OLSconstrained(Y, X, Bcon, G)

Arguments

Y left hand side variables (M x T)
X regressors (i.e. N-1 variables + the intercept) (N x T)
Bcon constraints matrix (M x N). If Bcon(i,j) = nan -> B(i,j) is a free parameter
G weighting matrix (psd) - (M x M). Default is set to be identity

Details

# Estimate of B is obtained by minimizing the objective:
sum_t (Y_t*B X_t)' G^-1 (Y_t-B*X_t)
subject to the constraint that B = Bcon for all non-nan entries of Bcon

Value

matrix of coefficient (M x N)
### RemoveNA

**Description**

Exclude series that contain NAs

**Usage**

RemoveNA(YieldsData, MacroData, Economies)

**Arguments**

- **YieldsData**: List of country-specific bond yields
- **MacroData**: List of country-specific and global economic variables
- **Economies**: string-vector containing the names of the economies which are part of the economic system

**Value**

return the time series data that were not initially composed by NAs.

### RiskFactors

**Data: Risk Factors - Candelon and Moura (2021)**

**Description**

Risk factors data used in Candelon and Moura (2021)

**Usage**

data("CM_Factors")

**Format**

matrix containing the risk factors of the models

**References**

Candelon, B. and Moura, R. "A Multi-Country Model of the Term Structures of Interest Rates with a GVAR".


**RiskFactorsGraphs**

*Spanned and unspanned factors plot*

**Description**

Spanned and unspanned factors plot

**Usage**

```
RiskFactorsGraphs(ModelType, ModelOutputs, Economies, FactorLabels)
```

**Arguments**

- **ModelType**: string-vector containing the label of the model to be estimated
- **ModelOutputs**: list of model parameter estimates (see the "Optimization" function)
- **Economies**: string-vector containing the names of the economies which are part of the economic system
- **FactorLabels**: string-list based which contains the labels of all the variables present in the model

---

**RiskFactorsPrep**

*Builds the complete set of time series of the risk factors (spanned and unspanned)*

**Description**

Builds the complete set of time series of the risk factors (spanned and unspanned)

**Usage**

```
RiskFactorsPrep(
    FactorSet,
    Economies,
    FactorLabels,
    Initial_Date,
    Final_Date,
    DataFrequency
)
```
Arguments

FactorSet  Factor set list (see e.g. "CM_Factors_GVAR" data file)
Economies  string-vector containing the names of the economies which are part of the economic system
FactorLabels  string-list based which contains the labels of all the variables present in the model
Initial_Date  Sample starting date (yyyy-mm-dd)
Final_Date  Sample last date (yyyy-mm-dd)

Value

Risk factors used in the estimation of the desired ATSM

RMSEjoint

Compute the root mean square error ("joint Q" models)

Description

Compute the root mean square error ("joint Q" models)

Usage

RMSEjoint(ForecastOutputs)

Arguments

ForecastOutputs  List of country-specific forecasts (see "ForecastYieldsjointQ" function)

RMSEsep

Compute the root mean square error ("sep Q" models)

Description

Compute the root mean square error ("sep Q" models)

Usage

RMSEsep(ForecastOutputs)

Arguments

ForecastOutputs  List of country-specific forecasts (see "ForecastYieldsSepQ" function)
SpannedFactorsjointQ  
Gather all spanned factors ("joint Q" models)

Description
Gather all spanned factors ("joint Q" models)

Usage
SpannedFactorsjointQ(ModelType, ModelPara, Economies, t0Sample, tlastObserved)

Arguments

- **ModelType**: string-vector containing the label of the model to be estimated
- **ModelPara**: set of model parameters
- **Economies**: string-vector containing the names of the economies which are part of the economic system
- **t0Sample**: index for the initial sample date
- **tlastObserved**: index for the last observation of the information set

---------------------

SpannedFactorsSepQ  
Gather all spanned factors ("sep Q" models)

Description
Gather all spanned factors ("sep Q" models)

Usage
SpannedFactorsSepQ(ModelType, ModelPara, Economies, t0Sample, tlastObserved)

Arguments

- **ModelType**: string-vector containing the label of the model to be estimated
- **ModelPara**: set of model parameters
- **Economies**: string-vector containing the names of the economies which are part of the economic system
- **t0Sample**: index for the initial sample date
- **tlastObserved**: index for the last observation of the information set
Spanned_Factors: Compute the country-specific spanned factors

Description
Compute the country-specific spanned factors

Usage
Spanned_Factors(Yields, Economies, N)

Arguments
- **Yields**: matrix (J x T), where J - the number of maturities and T - time series length
- **Economies**: C-dimensional string-vector containing the names of the economies which are part of the economic system
- **N**: scalar: desired number of spanned factors (maximum number allowed is N= J)

Value
Matrix containing the N spanned for all the countries of the system (CJ xT)

Examples
```r
data(CM_Yields)
Economies <- c("China", "Brazil", "Mexico", "Uruguay")
N <- 3
Spanned_Factors(Yields, Economies, N)
```

sqrtm_robust: Compute the square root of a matrix

Description
Compute the square root of a matrix

Usage
sqrtm_robust(m)

Arguments
- **m**: squared matrix (KxK)
Value

Squared matrix $x$ ($K \times K$) such that $x$

References

`# This function is a modified version of the "sqrtm_robust" function by Le and Singleton (2018).  
"A Small Package of Matlab Routines for the Estimation of Some Term Structure Models."  
(Euro Area Business Cycle Network Training School - Term Structure Modelling). Available at: https://cepr.org/40029`

---

**StarFactors**  
Generates the star variables necessary for the GVAR estimation

**Description**

Generates the star variables necessary for the GVAR estimation

**Usage**

```r
StarFactors(RiskFactors, Economies, W)
```

**Arguments**

- **RiskFactors**: time series of the risk factors ($F \times T$)
- **Economies**: string-vector containing the names of the economies which are part of the economic system
- **W**: GVAR transition matrix ($C \times C$)

**Value**

List containing the star factors of each country of the economic system

**Examples**

```r
data(CM_Factors)  
Economies <- c("China", "Brazil", "Mexico", "Uruguay")  
Wgvar <- matrix(  
c(0, 0.83, 0.86, 0.38, 0.65, 0, 0.13, 0.55, 0.32, 0.12, 0, 0.07, 0.03, 0.05, 0.01, 0),  
nrow = 4, ncol = 4)  
rownames(Wgvar) <- Economies  
colnames(Wgvar) <- Economies  
StarFactors(RiskFactors, Economies, Wgvar)
```
Transition_Matrix

TradeFlows  

\textit{Data: Trade Flows - Candelon and Moura (2021)}

\textbf{Description}

Trade Flows data used in Candelon and Moura (2021)

\textbf{Usage}

\begin{verbatim}
data("CM_Trade")
\end{verbatim}

\textbf{Format}

list containing the bilateral trade flows

\textbf{References}

Candelon, B. and Moura, R. "A Multi-Country Model of the Term Structures of Interest Rates with a GVAR".

\begin{verbatim}
Transition_Matrix

\textit{Compute the transition matrix required in the estimation of the GVAR model}

\textbf{Description}

Compute the transition matrix required in the estimation of the GVAR model

\textbf{Usage}

\begin{verbatim}
Transition_Matrix(  
t_First,  
t_Last,  
Economies,  
type,  
DataPath = NULL,  
Data = NULL  
)
\end{verbatim}
true2aux

Map constrained parameters b to unconstrained auxiliary parameters a.

Description
Map constrained parameters b to unconstrained auxiliary parameters a.

Usage
true2aux(b, ctype, lb, ub, Economies, FactorLabels, JLLinputs = NULL)
Arguments

- **b**: Constrained parameter
- **ctype**: character-based vector that describes the constraints. Constraints are:
  - 'Jordan';
  - 'Jordan; stationary'
  - 'Jordan MultiCountry'
  - 'Jordan MultiCountry; stationary'
  - 'stationary'
  - 'psd'
  - 'BlockDiag'
  - 'bounded'
  - 'diag'
  - 'JLLstructure'
- **lb**: lower bounds of b (for the bounded case). Accomodates a scalar or a matrix.
- **ub**: upper bounds of b (for the bounded case). Accomodates a scalar or a matrix.
- **Economies**: string-vector containing the names of the economies which are part of the economic system
- **FactorLabels**: string-list based which contains the labels of all the variables present in the model
- **JLLinputs**: list of necessary inputs for the estimation of JLL-based models (see "JLL" function)

Value

unconstrained auxiliary matrix.

References

This function is a modified and extended version of the "true2aux" function by Le and Singleton (2018).

---

**update_para**

converts the vectorized auxiliary parameter vector x to the parameters that go directly into the likelihood function.

Description

converts the vectorized auxiliary parameter vector x to the parameters that go directly into the likelihood function.
usage

update_para(  
  x,  
  sizex,  
  ii,  
  con,  
  FactorLabels,  
  Economies,  
  JLLinputs = NULL,  
  GVARinputs = NULL,  
  varargin  
)

arguments

x vector containing all the vectorized auxiliary parameters  
sizex matrix (6x2) containing the size information of all parameters  
ii if empty: converts all the parameters; otherwise converts some specific parameters  
con if con = 'concentration', then set the value of the parameter whose name contains @ to empty  
FactorLabels string-list based which contains the labels of all the variables present in the model  
Economies string-vector containing the names of the economies which are part of the economic system  
JLLinputs Set of necessary inputs used in the estimation of the JLL-based models  
GVARinputs Set of necessary inputs used in the estimation of the GVAR-based models  
varargin variable inputs used in the optimization (see "Optimization" function)

value

same form as varargin, except now the parameters are updated with the values provided by the auxiliary x. Importantly, by construction, all the constraints on the underlying parameters are satisfied.

references

This function is a modified version of the "update_para" function by Le and Singleton (2018). "A Small Package of Matlab Routines for the Estimation of Some Term Structure Models." (Euro Area Business Cycle Network Training School - Term Structure Modelling). Available at: https://cepr.org/40029
**VAR**

*Estimates a VAR(1)*

**Description**

Estimates a VAR(1)

**Usage**

`VAR(RiskFactors, VARtype, Bcon = NULL)`

**Arguments**

- `RiskFactors` : matrix containing all the risk factors (K x T)
- `VARtype` : string-vector which accommodates two possibilities: 'unconstrained' or 'constrained'
- `Bcon` : constraints matrix (K+1 x N) - should contain an intercept. If Bcon(i,j) = nan --> B(i,j) is a free parameter. Default is set to NULL.

**Value**

intercept, feedback matrix and the variance-covariance matrix of a VAR(1)

**Examples**

```r
data("CM_Factors")
#Example 1
VAR(RiskFactors, VARtype = 'unconstrained')
#Example 2
K <- nrow(RiskFactors)
Bcon <- matrix(0, nrow = K, ncol = K+1)
Bcon[,1:3] <- NaN
VAR(RiskFactors, VARtype = 'constrained', Bcon)
```

---

**VarianceExplainedJoint**

*Percentage explained by the spanned factors of the variations in the set of observed yields for "joint Q" models*

**Description**

Percentage explained by the spanned factors of the variations in the set of observed yields for "joint Q" models
VarianceExplainedSep

Usage

VarianceExplainedJoint(ModelType, ModelPara, FactorLabels, Economies)

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ModelType</td>
<td>string-vector containing the label of the model to be estimated</td>
</tr>
<tr>
<td>ModelPara</td>
<td>list of model parameter estimates (see the &quot;Optimization&quot; function)</td>
</tr>
<tr>
<td>FactorLabels</td>
<td>string-list based which contains all the labels of all the variables present in the model</td>
</tr>
<tr>
<td>Economies</td>
<td>string-vector containing the names of the economies which are part of the economic system</td>
</tr>
</tbody>
</table>

VarianceExplainedSep  
*Percentage explained by the spanned factors of the variations in the set of observed yields for "sep Q" models*

Description

Percentage explained by the spanned factors of the variations in the set of observed yields for "sep Q" models

Usage

VarianceExplainedSep(ModelType, ModelPara, FactorLabels, Economies)

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ModelType</td>
<td>string-vector containing the label of the model to be estimated</td>
</tr>
<tr>
<td>ModelPara</td>
<td>List of model parameter estimates (see the &quot;Optimization&quot; function)</td>
</tr>
<tr>
<td>FactorLabels</td>
<td>string-list based which contains all the labels of all the variables present in the model</td>
</tr>
<tr>
<td>Economies</td>
<td>string-vector containing the names of the economies which are part of the economic system</td>
</tr>
</tbody>
</table>
**x2bound**

*Transform x to a number bounded btw lb and ub by:*

**Description**

Transform x to a number bounded btw lb and ub by:

**Usage**

```matlab
x2bound(x, lb, ub, nargout)
```

**Arguments**

- **x**: number to be transformed (scalar)
- **lb**: lower bound (scalar)
- **ub**: upper bound (scalar)
- **nargout**: "1" or "2" (scalar)

**References**

This function is based on the "x2bound" function by Le and Singleton (2018).
"A Small Package of Matlab Routines for the Estimation of Some Term Structure Models."
(Euro Area Business Cycle Network Training School - Term Structure Modelling). Available at: 
https://cepr.org/40029

---

**x2pos**

*Transform x to a positive number by: y = log(e^x + 1)*

**Description**

Transform x to a positive number by: $y = \log(e^x + 1)$

**Usage**

```matlab
x2pos(x, nargout)
```

**Arguments**

- **x**: scalar or vector
- **nargout**: 1 or 2

**References**

This function is based on the "x2pos" function by Le and Singleton (2018).
"A Small Package of Matlab Routines for the Estimation of Some Term Structure Models."
(Euro Area Business Cycle Network Training School - Term Structure Modelling) Available at: 
https://cepr.org/40029
Yields

Data: Yields - Candelon and Moura (2021)

Description

Yields data used in Candelon and Moura (2021)

Usage

data("CM_Yields")

Format

matrix containing the Yields of the models

References

Candelon, B. and Moura, R. "A Multi-Country Model of the Term Structures of Interest Rates with a GVAR".

YieldsFitJoint

Computes two measures of model fit for bond yields

Description

Computes two measures of model fit for bond yields

Usage

YieldsFitJoint(ModelType, ModelPara, FactorLabels, Economies)

Arguments

ModelType string-vector containing the label of the model to be estimated
ModelPara list of model parameter estimates (see the "Optimization" function)
FactorLabels string-list based which contains all the labels of all the variables present in the model
Economies string-vector containing the names of the economies which are part of the economic system

Details

"Model-implied yields" is the measure of fit based exclusively on the risk-neutral parameters, whereas the "Model-Fit" takes into account both the risk-neutral and the physical parameters.
YieldsFitsep

Computes two measures of model fit for bond yields

Description

Computes two measures of model fit for bond yields

Usage

YieldsFitsep(ModelType, ModelPara, FactorLabels, Economies)

Arguments

- **ModelType**: a string-vector containing the label of the model to be estimated
- **ModelPara**: List of model parameter estimates (See the "Optimization" function)
- **FactorLabels**: a string-list based which contains the labels of all the variables present in the model
- **Economies**: a string-vector containing the names of the economies which are part of the economic system

Details

"Model-implied yields" is the measure of fit based exclusively on the risk-neutral parameters, whereas the "Model-Fit" takes into account both the risk-neutral and the physical parameters.

References

Index

* (2014)
  BR_jps_out, 16
  ModelPara, 81
* Factors
  FactorsGVAR, 23
  RiskFactors, 94
* Flows
  TradeFlows, 100
* GVAR
  FactorsGVAR, 23
* JPS
  BR_jps_out, 16
  ModelPara, 81
* Risk
  FactorsGVAR, 23
  RiskFactors, 94
* Trade
  TradeFlows, 100
* Yields
  Yields, 107
* outputs
  BR_jps_out, 16
  ModelPara, 81
  contain, 18
  DatabasePrep, 19
  DataForEstimation, 20
  DataSet_BS, 21
df__dx, 22
  f_with_vectorized_parameters, 38
  FactorsGVAR, 23
  FEVandGFEDbs_jointQ, 23
  FEVandGFEDbs_jointQ_Ortho, 24
  FEVandGFEDbs_sepQ, 25
  FEVDgraphsJLLortho, 25
  FEVDgraphsJoint, 26
  FEVDgraphsSep, 27
  FEVDjoint, 28
  FEVDjoint_BS, 29
  FEVDjointOrthoJLL, 28
  FEVDjointOrthoJLL_BS, 29
  FEVDsep, 30
  FEVDsep_BS, 31
  FitgraphsJoint, 31
  FitgraphsSep, 32
  FMN__Rotate, 33
  ForecastYields, 34
  ForecastYieldsJointQ, 35
  ForecastYieldsSepQ, 36
  Functionf, 37
  GaussianDensity, 40
  getpara, 40
  getx, 41
  GFEDgraphsJLLortho, 42
  GFEDgraphsJoint, 42
  GFEDgraphsSep, 43
  GFEDjoint, 44
  GFEDjoint_BS, 46
  GFEDjointOrthoJLL, 45
  GFEDjointOrthoJLL_BS, 45
A0N__computeBnAn_jointQ, 10
A0N__computeBnAn_sepQ, 11
A0N_MLEdensity_WOE__jointQ_Bootstrap, 4
  contain, 18
A0N_MLEdensity_WOE__jointQ_sepSigma_Bootstrap, 6
A0N_MLEdensity_WOE__sepQ_Bootstrap, 8
aux2true, 12
Bootstrap, 13
BootstrapBoundsSet, 14
bound2x, 15
BR_jps_out, 16
BUnspannedAdapJoint, 16
BUnspannedAdapSep, 17
BUnspannedAdapSep_BS, 17