Package ‘DeRezende.Ferreira’

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Title Zero Coupon Yield Curve Modelling

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Description Modeling the zero coupon yield curve using the dynamic De Rezende and Ferreira (2011) <doi:10.1002/for.1256> five factor model with variable or fixed decaying parameters. For explanatory purposes, the package also includes various short datasets of interest rates for the BRICS countries.

Depends R (>= 3.5.0), xts, stats

License GPL (>= 2)

Encoding UTF-8

LazyData true

RoxygenNote 6.1.1

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DeRezende.Ferreira-package

Zero Coupon Yield Curve Modelling

Description

Modeling the zero coupon yield curve using the dynamic De Rezende and Ferreira (2011) <doi:10.1002/for.1256> five factor model with variable or fixed decaying parameters. For explanatory purposes, the package also includes various short datasets of interest rates for the BRICS countries.

Details

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RoxygenNote:	6.1.1

Author(s)

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References

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DRF.5F.rates *Estimation of spot rates with the De Rezende-Ferreira 5 Factor model*

Description

The command estimates the spot rates using the De Rezende-Ferreira 5 Factor model

Usage

```
DRF.5F.rates(beta, maturity)
```

Arguments

beta	Matrix or Vector of class "zoo", which contains the coefficients of the De Rezende-Ferreira 5 Factor model: $(\beta_{0t}, \beta_{1t}, \beta_{2t}, \beta_{3t}, \beta_{4t}, \tau_{1t}, \tau_{2t})$
maturity	Vector of class "numeric", wich contains the maturities

Value

An object of class "xts" - "zoo", which contains fitted interest rates

Examples

```
#
# Fitting the Chinese spot rates using the De Rezende-Ferreira 5F moodel with Variable tau
#

data(ZC_China)
real.rate = ZC_China
ZC_China[["Date"]] = NULL
rate = zoo(ZC_China)
index(rate) = as.POSIXct(paste(real.rate[["Date"]]))
maturity <- c(1,2,3,4,5,6,7,8,9,10,12,15,20,30)
```

```
RF.5F.Parameters <- DRF.5F.tVar(rate, maturity)
RF.5F.Rates <- DRF.5F.rates(RF.5F.Parameters, maturity )

plot(maturity,rate[5,],xlab="Maturity",ylab="Yields",ylim=c(3.5,4.7),col="black",lwd = 1)
lines(maturity, RF.5F.Rates[5,], col = "blue", lwd = 1)
grid(nx = 12, ny = 12)

#
#
#
#
# Fitting the South African spot rates using the De Rezende-Ferreira 5F model with fixed tau
#

data(ZC_SouthAfrica)
real.rate = ZC_SouthAfrica
ZC_SouthAfrica[["Date"]] = NULL
rate = zoo(ZC_SouthAfrica)
index(rate) = as.POSIXct(paste(real.rate[["Date"]]))
maturity <- c(0.25, 1,2,3,4,5,6,7,8,9,10,12,15,20,25,30)
fixed_tau1 = (1.07612)
fixed_tau2 = (6.23293)

RF.5F.Parameters <- DRF.5F.tFix(rate, maturity, fixed_tau1, fixed_tau2)
RF.5F.Rates <- DRF.5F.rates(RF.5F.Parameters, maturity )

plot(maturity,rate[5,],xlab="Maturity",ylab="Yields",ylim=c(6.5,10.0),col="black",lwd = 1)
lines(maturity, RF.5F.Rates[5,], col = "blue", lwd = 1)
grid(nx = 12, ny = 12)
```

`DRF.5F.tFix` *Estimation of the De Rezende-Ferreira 5 Factor model's parameters with fixed* τ

Description

The command estimates the parameters of the De Rezende-Ferreira 5 Factor model using fixed τ_1 and τ_2

Usage

```
DRF.5F.tFix(rate, maturity, fixed_tau1, fixed_tau2)
```

Arguments

`rate`	Vector or matrix of class "zoo", which contains interest rates
`maturity`	Vector of class "numeric", wich contains the maturities
`fixed_tau1`	Decaying parameter of class "numeric" (Slope)
`fixed_tau2`	Decaying parameter of class "numeric" (Curvature)

Value

An object of class "zoo", that contains $\left(\beta_{0t},\ \beta_{1t},\ \beta_{2t},\ \beta_{3t},\ \beta_{4t},\ \tau_{1t},\ \tau_{2t},\ SSR_t,\ R_t^2\right)$

Examples

```
#
# De Rezende-Ferreira 5F model on the Indian Data-Set
#

data(ZC_India)
real.rate = ZC_India
ZC_India[["Date"]] = NULL
rate = zoo(ZC_India)
index(rate) = as.POSIXct(paste(real.rate[["Date"]]))
maturity <- c(0.25, 0.5, 0.75, 1,2,3,4,5,6,7,8,9,10,12,15,20,25,30)
fixed_tau1 = (1.07612)
fixed_tau2 = (6.23293)

RF.5F.Parameters <- DRF.5F.tFix(rate, maturity, fixed_tau1, fixed_tau2)

par(mfrow=c(3,2))
 plot(RF.5F.Parameters[,"beta0"],xlab="Date",ylab="BETA0",ylim=c(7.0,9.0),col="blue",lwd=1)
 grid(nx=12, ny=12)
 plot(RF.5F.Parameters[,"beta1"],xlab="Date",ylab="BETA1",ylim=c(-3.5,0.2),col="blue",lwd=1)
 grid(nx=12, ny=12)
 plot(RF.5F.Parameters[,"beta2"],xlab="Date",ylab="BETA2",ylim=c(-1.5,1.0),col="blue",lwd=1)
 grid(nx=12, ny=12)
 plot(RF.5F.Parameters[,"beta3"],xlab="Date",ylab="BETA3",ylim=c(-2.0,0.5),col="blue",lwd=1)
 grid(nx=12, ny=12)
 plot(RF.5F.Parameters[,"beta4"],xlab="Date",ylab="BETA4",ylim=c(-2.5,5.0),col="blue",lwd=1)
 grid(nx=12, ny=12)
par(mfrow=c(1,1))
```

DRF.5F.tVar — *Estimation of the De Rezende-Ferreira 5 Factor model's parameters with variable* τ

Description

The command estimates the parameters of the De Rezende-Ferreira 5 Factor model using variable τ_1 and τ_2

Usage

```
DRF.5F.tVar(rate, maturity)
```

Arguments

`rate`	Vector or matrix of class "zoo", which contains interest rates
`maturity`	Vector of class "numeric", wich contains the maturities

Details

The De Rezende-Ferreira model used to fit the forward rates is:

$$f_t\left(m\right) = \beta_{0t} + \beta_{1t} e^{-\frac{m}{\tau_{1t}}} + \beta_{2t} e^{-\frac{m}{\tau_{2t}}} + \beta_{3t}\left(\frac{m}{\tau_{1t}} e^{-\frac{m}{\tau_{1t}}}\right) + \beta_{4t}\left(\frac{m}{\tau_{2t}} e^{-\frac{m}{\tau_{2t}}}\right)$$

The spot rates, derived from the forward rates $f_t\left(m\right)$, are given by:

$$y_t\left(m\right) = \beta_{0t} + \beta_{1t}\left(\frac{1-e^{-\frac{m}{\tau_{1t}}}}{\frac{m}{\tau_{1t}}}\right) + \beta_{2t}\left(\frac{1-e^{-\frac{m}{\tau_{2t}}}}{\frac{m}{\tau_{2t}}}\right) + \beta_{3t}\left(\frac{1-e^{-\frac{m}{\tau_{1t}}}}{\frac{m}{\tau_{1t}}} - e^{-\frac{m}{\tau_{1t}}}\right) + \beta_{4t}\left(\frac{1-e^{-\frac{m}{\tau_{2t}}}}{\frac{m}{\tau_{2t}}} - e^{-\frac{m}{\tau_{2t}}}\right)$$

The set of optimal parameters will be chosen according to the lowest RMSE value:

$$\left(\widehat{\tau}_{1t}, \widehat{\tau}_{2t}\right) = argmin\left\{\frac{1}{N}\sum_{t=1}^{N}\sqrt{\frac{1}{T}\sum_{t=1}^{T}\left[y_t\left(t_n\right) - \widehat{y}_t\left(t_n, \tau_{1t}, \tau_{2t}, \widehat{\beta}_t\right)\right]^2}\right\}$$

Value

An object of class "zoo", that contains $\left(\beta_{0t},\ \beta_{1t},\ \beta_{2t},\ \beta_{3t},\ \beta_{4t},\ \tau_{1t},\ \tau_{2t},\ SSR_t,\ R_t^2\right)$

Examples

```
#
# De Rezende-Ferreira 5F model on the Brazilian Data-Set
#

data(ZC_Brazil)
real.rate = ZC_Brazil

ZC_Brazil[["Date"]] = NULL

rate = zoo(ZC_Brazil)
index(rate) = as.POSIXct(paste(real.rate[["Date"]]))
```

```
maturity <- c(0.5, 0.75, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10)

RF.5F.Parameters <- DRF.5F.tVar(rate, maturity)

par(mfrow=c(3,2))
 plot(RF.5F.Parameters[,"beta0"],xlab="Date",ylab="BETA0",ylim=c(9.5,12.0),col="blue",lwd=1)
 grid(nx=12, ny=12)
 plot(RF.5F.Parameters[,"beta1"],xlab="Date",ylab="BETA1",ylim=c(-18.0,2.3),col= "blue",lwd=1)
 grid(nx=12, ny=12)
 plot(RF.5F.Parameters[,"beta2"],xlab="Date",ylab="BETA2",ylim=c(-6.0,13.0),col= "blue",lwd=1)
 grid(nx=12, ny=12)
 plot(RF.5F.Parameters[,"beta3"],xlab="Date",ylab="BETA3",ylim=c(-10.0,0.0),col= "blue",lwd=1)
 grid(nx=12, ny=12)
 plot(RF.5F.Parameters[,"beta4"],xlab="Date",ylab="BETA4",ylim=c(-5.0,5.0),col="blue",lwd=1)
 grid(nx=12, ny=12)
par(mfrow=c(1,1))

par(mfrow=c(2,1))
 plot(RF.5F.Parameters[,"tau1"],xlab="Date",ylab="TAU1",ylim=c(0.2,1.3),col="blue",lwd=1)
 grid(nx=12, ny=12)
 plot(RF.5F.Parameters[,"tau2"],xlab="Date",ylab="TAU2",ylim=c(2.5,5.5),col="blue",lwd=1)
 grid(nx=12, ny=12)
par(mfrow=c(1,1))

#
# De Rezende-Ferreira 5F on the Russian Data-Set
#

data(ZC_Russia)
real.rate = ZC_Russia

ZC_Russia[["Date"]] = NULL

rate = zoo(ZC_Russia)
index(rate) = as.POSIXct(paste(real.rate[["Date"]]))
maturity <- c(0.25, 0.5, 0.75, 1,2,3,5,7,10,15,20,30)
RF.5F.Parameters <- DRF.5F.tVar(rate, maturity)

par(mfrow=c(3,2))
 plot(RF.5F.Parameters[,"beta0"],xlab="",ylab="BETA0",ylim=c(10.5,12.5),col="blue",lwd=1)
 grid(nx=12, ny=12)
 plot(RF.5F.Parameters[,"beta1"],xlab="Date",ylab="BETA1",ylim=c(-1.5,0.5),col="blue",lwd=1)
 grid(nx=12, ny=12)
 plot(RF.5F.Parameters[,"beta2"],xlab="Date",ylab="BETA2",ylim=c(-7.0,-3.5),col="blue",lwd=1)
 grid(nx=12, ny=12)
 plot(RF.5F.Parameters[,"beta3"],xlab="Date",ylab="BETA3",ylim=c(-1.5,3.5),col="blue",lwd=1)
 grid(nx=12, ny=12)
 plot(RF.5F.Parameters[,"beta4"],xlab="Date",ylab="BETA4",ylim=c(-5.5,-0.1),col="blue",lwd=1)
 grid(nx=12, ny=12)
par(mfrow=c(1,1))


par(mfrow=c(2,1))
```

```
 plot(RF.5F.Parameters[,"tau1"],xlab="Date",ylab="TAU1",ylim=c(0.1,1.9),col="blue",lwd=1)
  grid(nx=12, ny=12)
 plot(RF.5F.Parameters[,"tau2"],xlab="Date",ylab="TAU2",ylim=c(7.5,16.8),col="blue",lwd=1)
  grid(nx=12, ny=12)
par(mfrow=c(1,1))
```

ZC_Brazil *Zero-Coupon interest rates*

Description

ZC Government bonds with maturities (0.5, 0.75, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10) expressed in years and with business day frequency, source: Thomson Reuters Datastream. The range date is from 2018-01-01 to 2018-01-12.

Usage

```
data(ZC_Brazil)
```

Format

A data frame (txt file) with 12 daily interest rates at different maturities and 10 observed days.

ZC_China *Zero-Coupon interest rates*

Description

ZC Government bonds with maturities (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 20, 30) expressed in years and with business day frequency, source: Thomson Reuters Datastream. The range date is from 2018-01-02 to 2018-01-15.

Usage

```
data(ZC_China)
```

Format

A data frame (txt file) with 14 daily interest rates at different maturities and 10 observed days.

`ZC_India` *Zero-Coupon interest rates*

Description

ZC Government bonds with maturities (0.25 , 0.5, 0.75, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 20, 25, 30) expressed in years and with business day frequency, source: Thomson Reuters Datastream. The range date is from 2018-01-01 to 2018-01-12.

Usage

```
data(ZC_India)
```

Format

A data frame (txt file) with 18 daily interest rates at different maturities and 10 observed days.

`ZC_Russia` *Zero-Coupon interest rates*

Description

ZC Government bonds with maturities (0.25, 0.5, 0.75, 1,2,3,5,7,10,15,20,30) expressed in years and with business day frequency, source: the Central Bank of the Russian Federation web site. The range date is from 2018-01-03 to 2018-01-17.

Usage

```
data(ZC_Russia)
```

Format

A data frame (txt file) with 12 daily interest rates at different maturities and 10 observed days.

`ZC_SouthAfrica` *Zero-Coupon interest rates*

Description

ZC Government bonds with maturities (0.25, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 20, 25, 30) expressed in years and with business day frequency, source: Thomson Reuters Datastream. The range date is from 2018-01-01 to 2018-01-12.

Usage

```
data(ZC_SouthAfrica)
```

Format

A data frame (txt file) with 16 daily interest rates at different maturities and 10 observed days.

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