Package: YieldCurve (via r-universe)

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Title Modelling and Estimation of the Yield Curve

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Depends R (>= 2.10), xts

Description Modelling the yield curve with some parametric models. The models implemented are: Nelson, C.R., and A.F. Siegel (1987) <doi:10.1086/296409>, Diebold, F.X. and Li, C. (2006) <doi:10.1016/j.jeconom.2005.03.005> and Svensson, L.E. (1994) <doi:10.3386/w4871>. The package also includes the data of the term structure of interest rate of Federal Reserve Bank and European Central Bank.

License GPL (>= 2)

NeedsCompilation no

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Contents

`YieldCurve-package` *Modelling and estimation of the yield curve*

Description

Modelling the yield curve with some parametric models. The models implemented are: Nelson-Siegel, Diebold-Li and Svensson. The package also includes the data of the term structure of interest rate of Federal Reserve Bank and European Central Bank.

Details

Package:	YieldCurve
Type:	Package
Version:	5
Date:	2022-09-30
License:	GPL (>= 2)
LazyLoad:	yes

DieboldLi

Author(s)

Sergio Salvino Guirreri

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References

Diebold, F.X. and Li, C. (2006), Forecasting the Term Structure of Government Bond Yields, *Journal of Econometrics*, **130**, 337-364.

Diebold, F.X., Ji, L. and Li, C. (2006), A Three-Factor Yield Curve Model: Non-Affine Structure, Systematic Risk Sources, and Generalized Duration, in L.R. Klein (ed.), *Long-Run Growth and Short-Run Stabilization: Essays in Memory of Albert Ando*. Cheltenham, U.K.: Edward Elgar, 240-274.

Nelson, C.R., and A.F. Siegel (1987), Parsimonious Modeling of Yield Curve, *The Journal of Business*, **60**, 473-489.

Svensson, L.E. (1994), Estimating and Interpreting Forward Interest Rates: Sweden 1992-1994, *IMF Working Paper*, **WP/94/114**.

Examples

```
### Nelson.Siegel function and Fed data-set ###
data(FedYieldCurve)
rate.Fed = first(FedYieldCurve,'5 month')
maturity.Fed <- c(3/12, 0.5, 1,2,3,5,7,10)
```

```
NSParameters <- Nelson.Siegel( rate= rate.Fed, maturity=maturity.Fed )
y <- NSrates(NSParameters[5,], maturity.Fed)
plot(maturity.Fed,rate.Fed[5,],main="Fitting Nelson-Siegel yield curve", type="o")
lines(maturity.Fed,y, col=2)
legend("topleft",legend=c("observed yield curve","fitted yield curve"),
col=c(1,2),lty=1)

### Svensson function and ECB data-set ###
data(ECBYieldCurve)
rate.ECB = ECBYieldCurve[1:5,]
maturity.ECB = c(0.25,0.5,seq(1,30,by=1))
SvenssonParameters <- Svensson(rate.ECB, maturity.ECB)
Svensson.rate <- Srates( SvenssonParameters ,maturity.ECB,"Spot")

plot(maturity.ECB, rate.ECB[5,],main="Fitting Svensson yield curve", type="o")
lines(maturity.ECB, Svensson.rate[5,], col=2)
legend("topleft",legend=c("observed yield curve","fitted yield curve"),
col=c(1,2),lty=1)
```

ECBYieldCurve — *Yield curve data spot rate, AAA-rated bonds, maturities from 3 months to 30 years*

Description

Government bond, nominal, all triple A issuer companies. The maturities are 3 and 6 months and from 1 year to 30 years with frequency business day, provided by European Central Bank. The range date is from 2006-12-29 to 2009-07-24.

Usage

```
data(ECBYieldCurve)
```

Format

It is an `xts` object with 32 interest rate at different maturities and 655 observations.

Source

ECB: https://www.ecb.europa.eu/stats/financial_markets_and_interest_rates/euro_area_yield_curves/html/index.en.html.

Examples

```
### plot ECB Yield Curve ###
data(ECBYieldCurve)

first(ECBYieldCurve,'3 day')
```

```
last(ECBYieldCurve,'3 day')

mat.ECB <- tau <- c(3/12,6/12,1:30)

par(mfrow=c(2,3))
for( i in c(1,2,3,653,654,655) ){
plot(mat.ECB, ECBYieldCurve[i,], type="o", xlab="Maturity in years", ylab="IR values")
title(main=paste("European Central Bank yield curve obeserved at",time(ECBYieldCurve[i], sep=" ") ))
grid()
}
```

`FedYieldCurve` *Federal Reserve interest rates*

Description

The data-set contains the interest rates of the Federal Reserve, from January 1982 to December 2012. The interest rates are Market yield on U.S. Treasury securities constant maturity (CMT) (more information on the Treasury yield curve can be found at the following website https://home.treasury.gov/policy-issues/financing-the-government/interest-rate-statistics) at different maturities (3 months, 6 months, 1 year, 2 years, 3 years, 5 years, 7 years and 10 years), quoted on investment basis and have been gathered with monthly frequency.

Usage

```
data(FedYieldCurve)
```

Format

An object with class attributes `xts`.

Source

FED: https://www.federalreserve.gov/datadownload/Build.aspx?rel=H15.

Examples

```
require(xts)
require(YieldCurve)
data(FedYieldCurve)

first(FedYieldCurve,'3 month')
last(FedYieldCurve,'3 month')
mat<-c(3/12, 0.5, 1,2,3,5,7,10)

par(mfrow=c(2,3))
for( i in c(1,2,3,370,371,372) ){
plot(mat, FedYieldCurve[i,], type="o", xlab="Maturity in years", ylab="IR values")
title(main=paste("Federal Reserve yield curve obeserved at",time(FedYieldCurve[i], sep=" ") ))
grid()
}
```

`Nelson.Siegel` *Estimation of the Nelson-Siegel parameters*

Description

Returns the estimated coefficients of the Nelson-Siegel's model.

Usage

```
Nelson.Siegel( rate, maturity )
```

Arguments

`rate`	vector or matrix which contains the interest rates.
`maturity`	vector which contains the maturity (in months) of the `rate`. The vector's length must be the same of the number of columns of the `rate`.

Details

The Nelson-Siegel's model to describe the yield curve is:

$$y_t(\tau) = \beta_{0t} + \beta_{1t}\frac{1-\exp(-\lambda\tau)}{\lambda\tau} + \beta_{2t}\left(\frac{1-\exp(-\lambda\tau)}{\lambda\tau} - \exp(-\lambda\tau)\right)$$

Value

Returns a data frame with the estimated coefficients: β_{0t}, β_{1t}, β_{2t}, and λ.

Author(s)

Sergio Salvino Guirreri

References

Diebold, F.X. and Li, C. (2006), Forecasting the Term Structure of Government Bond Yields, *Journal of Econometrics*, **130**, 337-364.

Diebold, F.X., Ji, L. and Li, C. (2006), A Three-Factor Yield Curve Model: Non-Affine Structure, Systematic Risk Sources, and Generalized Duration, in L.R. Klein (ed.), *Long-Run Growth and Short-Run Stabilization: Essays in Memory of Albert Ando*. Cheltenham, U.K.: Edward Elgar, 240-274.

Nelson, C.R., and A.F. Siegel (1987), Parsimonious Modeling of Yield Curve, *The Journal of Business*, **60**, 473-489.

See Also

NelsonSiegel, Svensson

Examples

```
data(FedYieldCurve)
maturity.Fed <- c(3/12, 0.5, 1,2,3,5,7,10)
NSParameters <- Nelson.Siegel( rate=first(FedYieldCurve,'10 month'), maturity=maturity.Fed)
y <- NSrates(NSParameters[5,], maturity.Fed)
plot(maturity.Fed,FedYieldCurve[5,],main="Fitting Nelson-Siegel yield curve",
  xlab=c("Pillars in months"), type="o")
lines(maturity.Fed,y, col=2)
legend("topleft",legend=c("observed yield curve","fitted yield curve"),
col=c(1,2),lty=1)
grid()
```

NSrates — *Interest rates of the Nelson-Siegel's model.*

Description

Returns the interest rates by Nelson-Siegel's model.

Usage

```
NSrates(Coeff, maturity)
```

Arguments

`Coeff`	Vector or matrix of the beta's coefficients and lambda as the function `Nelson.Siegel` returns.
`maturity`	maturity of the yield curve of which want to return the interest rates.

Details

`Coeff` is a vector or matrix of the four coefficients of the Nelson-Siegel's model: $(\beta_0; \beta_1; \beta_2; \lambda)$.

Value

Return interest rates in matrix object with number of rows equal to `nrow(betaCoeff)` and number of columns equal to `length(maturity)`.

Author(s)

Sergio Salvino Guirreri

References

Diebold, F.X. and Li, C. (2006), Forecasting the Term Structure of Government Bond Yields, *Journal of Econometrics*, **130**, 337-364.

Diebold, F.X., Ji, L. and Li, C. (2006), A Three-Factor Yield Curve Model: Non-Affine Structure, Systematic Risk Sources, and Generalized Duration, in L.R. Klein (ed.), *Long-Run Growth and Short-Run Stabilization: Essays in Memory of Albert Ando*. Cheltenham, U.K.: Edward Elgar, 240-274.

Nelson, C.R., and A.F. Siegel (1987), Parsimonious Modeling of Yield Curve, *The Journal of Business*, **60**, 473-489.

Examples

```
data(FedYieldCurve)
maturity.Fed <- c(3/12, 0.5, 1,2,3,5,7,10)
NSParameters <- Nelson.Siegel( rate = first(FedYieldCurve,'10 month'), maturity=maturity.Fed )
y <- NSrates(NSParameters[5,],maturity.Fed)
plot(maturity.Fed,FedYieldCurve[10,],main="Fitting Nelson-Siegel yield curve", type="o")
lines(maturity.Fed,y, col=2)
legend("topleft",legend=c("observed yield curve","fitted yield curve"),
col=c(1,2),lty=1)
grid()
```

Srates — *Interest rates of the Svensson's model.*

Description

Returns the interest rates by Svensson's model.

Usage

```
Srates(Coeff, maturity, whichRate = "Forward")
```

Arguments

`Coeff`	vector or matrix of the beta's coefficients and of λ_1 and λ_2.
`maturity`	maturity of the yield curve of which want to return the interest rates.
`whichRate`	which rate want to return: "Spot" or "Forward" rates.

Details

`Coeff` is a vector or matrix of the four coefficients of the Svensson's model, while `lambdaValues` is a vector or matrix of two lambda values of Svensson's model.

Value

Return interest rates in matrix object with number of rows equal to `nrow(Coeff)` and number of columns equal to `length(maturity)`.

Author(s)

Sergio Salvino Guirreri

References

Svensson, L.E. (1994), Estimating and Interpreting Forward Interest Rates: Sweden 1992-1994, *IMF Working Paper*, **WP/94/114**.

Nelson, C.R., and A.F. Siegel (1987), Parsimonious Modeling of Yield Curve, *The Journal of Business*, **60**, 473-489.

Examples

```
data(ECBYieldCurve)
rate.ECB = first(ECBYieldCurve,'2 day')
maturity.ECB = c(0.25,0.5,seq(1,30,by=1))
SvenssonParameters <- Svensson(rate.ECB, maturity.ECB)
Svensson.rate <- Srates( SvenssonParameters ,maturity.ECB,"Spot")

plot(maturity.ECB, last(rate.ECB,'1 day'),main="Fitting Svensson yield curve",
  xlab=c("Pillars in years"), ylab=c("Rates"),type="o")
lines(maturity.ECB, last(Svensson.rate,'1 day'), col=2)
legend("topleft",legend=c("observed yield curve","fitted yield curve"),
col=c(1,2),lty=1)
grid()
```

`Svensson` *Estimation of the Svensson parameters*

Description

Returns the estimated coefficients of the Svensson's model.

Usage

```
Svensson(rate, maturity )
```

Arguments

`rate`	vector or matrix which contains the interest rates.
`maturity`	vector which contains the maturity (in months) of the `rate`. The vector's length must be the same of the number of columns of the `rate`.

Details

The Svensson's model to describe the forward rate is:

$$y_t(\tau) = \beta_0 + \beta_1 \exp\left(-\frac{\tau}{\lambda_1}\right) + \beta_2 \frac{\tau}{\lambda_1} \exp\left(-\frac{\tau}{\lambda_1}\right) + \beta_3 \frac{\tau}{\lambda_2} \exp\left(-\frac{\tau}{\lambda_2}\right)$$

The spot rate can be derived from forward rate and it is given by:

$$y_t(\tau) = \beta_0 + \beta_1 \frac{1 - \exp(-\frac{\tau}{\lambda_1})}{\frac{\tau}{\lambda_1}} + \beta_2 \left[\frac{1 - \exp(-\frac{\tau}{\lambda_1})}{\frac{\tau}{\lambda_1}} - \exp(-\frac{\tau}{\lambda_1})\right] + \beta_3 \left[\frac{1 - \exp(-\frac{\tau}{\lambda_2})}{\frac{\tau}{\lambda_2}} - \exp(-\frac{\tau}{\lambda_2})\right]$$

Value

Returns a data frame with the estimated coefficients: β_0, β_1, β_2,β_3, λ_1 and λ_2.

Author(s)

Sergio Salvino Guirreri

References

Svensson, L.E. (1994), Estimating and Interpreting Forward Interest Rates: Sweden 1992-1994, *IMF Working Paper*, **WP/94/114**.

Nelson, C.R., and A.F. Siegel (1987), Parsimonious Modeling of Yield Curve, *The Journal of Business*, **60**, 473-489.

Examples

```
data(ECBYieldCurve)
maturity.ECB <- c(0.25,0.5,seq(1,30,by=1))
A <- Svensson(ECBYieldCurve[1:10,], maturity.ECB )
Svensson.rate <- Srates( A, maturity.ECB, "Spot" )
plot(maturity.ECB, Svensson.rate[5,],main="Fitting Svensson yield curve",
 xlab=c("Pillars in years"), type="l", col=3)
lines( maturity.ECB, ECBYieldCurve[5,],col=2)
legend("topleft",legend=c("fitted yield curve","observed yield curve"),
col=c(3,2),lty=1)
grid()
```

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