Package 'SMFI5'

February 19, 2015

Type Package

Title R functions and data from Chapter 5 of 'Statistical Methods for Financial Engineering'

Version 1.0

Date 2013-05-16

Author Bruno Remillard

Maintainer Bruno Remillard <bruno.remillard@hec.ca>

Description R functions and data from Chapter 5 of 'Statistical Methods for Financial Engineering', by Bruno Remillard, CRC Press, (2013).

License GPL (>= 2)

Depends ggplot2, reshape, corpcor

URL http://www.r-project.org, http://www.brunoremillard.com

NeedsCompilation no

Repository CRAN

Date/Publication 2013-05-18 01:56:20

R topics documented:

bond.cir 2
bond.vasicek 3
data.cir 4
data.vasicek 5
est.cir 5
est.feller 6
est.ou 7
est.vasicek 8
get.cir.param 9
get.vasicek.param 10
LogLikCIR 11
LogLikFeller 12

LogLikOU 13
LogLikVasicek 14
num.jacobian 15
sim.cir 16
sim.n.chi2 17
sim.vasicek 18

Index **19**

`bond.cir` *Simulates the values and yields of zero-coupon bonds when the spot rate is modeled by a Feller process.*

Description

Simulates the values and yields of zero-coupon bonds when the (annualized) spot rate (in percent) is modeled by a Feller process satisfying

dr = alpha(beta-r)dt + sigma sqrt(r) dW,

with market price of risk q = q1/sqrt(r) +q2 sqrt(r). The maturities are 1,3,6 and 12 months.

Usage

```
bond.cir(alpha, beta, sigma, q1, q2, r0, n, maturities, days = 360)
```

Arguments

`alpha`	Mean-reversion parameter.
`beta`	Long term mean.
`sigma`	Volatility parameter.
`q1`	Market prime of risk parameter.
`q2`	Market prime of risk parameter.
`r0`	Initial rate value.
`n`	Number of periods.
`maturities`	Maturities in years (row vector).
`days`	Days in a year convention (360 default).

Value

`P`	Bond values.
`R`	Annual rate for the bond.
`tau`	Maturities in years.

Note

Translated from Matlab by David-Shaun Guay (HEC Montreal grant).

Author(s)

Bruno Remillard

References

Chapter 5 of 'Statistical Methods for Financial Engineering, B. Remillard, CRC Press, (2013).

Examples

```
out = bond.cir(0.5,2.55,0.365,0.3,0,3.55,1080,c(1/12, 3/12, 6/12, 1),365)
```

---

bond.vasicek	*Simulates the values and yields of zero-coupon bonds when the spot rate is modeled by a Ornstein-Uhlenbeck process*

Description

Simulates the values and yields of zero-coupon bonds when the (annualized) spot rate (in percent) is modeled by a Ornstein-Uhlenbeck process satisfying dr <- alpha(beta-r)dt + sigma dW, with market price of risk q(r) <- q1+q2 r. The maturities are 1,3,6 and 12 months.

Usage

```
bond.vasicek(alpha, beta, sigma, q1, q2, r0, n, maturities, days = 360)
```

Arguments

alpha	Mean-reversion parameter.
beta	Long term mean.
sigma	Volatility parameter.
q1	Market prime of risk parameter.
q2	Market prime of risk parameter.
r0	Initial rate value.
n	Number of periods.
maturities	Maturities in years (row vector).
days	Days in a year convention (360 default).

Value

P	Bond values.
R	Annual rate for the bond.
tau	Maturities in years.

Note

Translated from Matlab by David-Shaun Guay (HEC Montreal grant).

Author(s)

Bruno Remillard

References

Chapter 5 of 'Statistical Methods for Financial Engineering, B. Remillard, CRC Press, (2013).

Examples

```
out = bond.vasicek(0.5,2.55,0.365,0.3,0,3.55,1080,c(1/12, 3/12, 6/12, 1),365);
```

---

data.cir *Yields and maturities simulated from the CIR model.*

Description

Yields and maturities simulated from the CIR model, wth parameters alpha = 0.5, beta = 2.55, sigma = 0.365, q1 = 0.3, q2 = 0, h = 1/360. The maturities are 1,3,6, and 12 months.

Usage

```
data(data.cir)
```

Format

The format is: c(R,tau) = [1:1440, 1:2] 3.73 3.78 3.79 3.83 3.83 ...

Source

The program bond.cir was used to simulate these data.

References

Chapter 5 of 'Statistical Methods for Financial Engineering, B. Remillard, CRC Press, (2013).

Examples

```
data(data.cir)
## maybe str(data.cir) ; plot(data.cir) ...
```

data.vasicek — *Yields and maturities simulated from the Vasicek model.*

Description

Yields and maturities simulated from the Vasicek model, wth parameters alpha = 0.5, beta = 2.55, sigma = 0.365, q1 = 0.3, q2 = 0, h = 1/360. The maturities are 1,3,6, and 12 months.

Usage

```
data(data.vasicek)
```

Format

The format is: c(R,tau) = [1:1440, 1:2] 3.73 3.78 3.79 3.83 3.83 ...

Source

The program bond.vasicek was used to simulate these data.

References

Chapter 5 of 'Statistical Methods for Financial Engineering, B. Remillard, CRC Press, (2013).

Examples

```
data(data.vasicek)
## maybe str(data.vasicek) ; plot(data.vasicek) ...
```

est.cir — *Estimates the parameters of the CIR model.*

Description

Estimates the parameters of the CIR model

dr = alpha(beta-r)dt + sigma sqrt(r) dW

with market price of risk q(r) = q1/sqrt(r) +q2 sqrt(r). The time scale is in years and the units are percentages.

Usage

```
est.cir(data, method = "Hessian", days = 360, significanceLevel = 0.95)
```

Arguments

`data`	c(R,tau) (n x 2), with R: annual bonds yields in percentage, and tau: maturities in years.
`method`	'Hessian' (default), 'num'.
`days`	Number of days per year (default: 360).
`significanceLevel`	95%(default).

Value

`theta`	Parameters (alpha, beta, sigma, q1,q2) of the model.
`error`	Estimation errors for the given confidence level.
`rimp`	Implied spot rate.

Note

Translated from Matlab by David-Shaun Guay (HEC Montreal grant).

Author(s)

Bruno Remillard

References

Chapter 5 of 'Statistical Methods for Financial Engineering, B. Remillard, CRC Press, (2013).

Examples

```
data(data.cir)
out = est.cir(data.cir,method='num')
```

`est.feller` *Estimates the parameters of the Feller process.*

Description

Estimates the parameters of the Feller process

dr = alpha(beta-r)dt + sigma sqrt(r) dW

The time scale is in years and the units are percentages.

Usage

```
est.feller(data, method = "Hessian", days = 360, significanceLevel = 0.95)
```

Arguments

`data`	annual bonds yields in percentage;
`method`	'Hessian' (default), 'num';
`days`	number of days per year (default: 360);
`significanceLevel`	(95% default).

Value

`param`	parameters (alpha, beta, sigma) of the model;
`error`	estimation errors for the given confidence level.

Note

Translated from Matlab by David-Shaun Guay (HEC Montreal grant).

Author(s)

Bruno Remillard

References

Chapter 5 of 'Statistical Methods for Financial Engineering, B. Remillard, CRC Press, (2013).

Examples

```
data(data.cir)
out = est.feller(data.cir[,1]) #The first colum contains returns.
```

`est.ou` *Estimates the parameters of the Ornstein-Uhlenbeck process.~~*

Description

Estimates the parameters of the Ornstein-Uhlenbeck process dr = alpha(beta-r)dt + sigma dW.

Usage

```
est.ou(data, method = "Hessian", days = 360, significanceLevel = 0.95)
```

Arguments

`data`	annual bonds yields in percentage;
`method`	'Hessian' (default), 'num';
`days`	number of days per year (default: 360);
`significanceLevel`	(95% default).

Value

`param`	parameters (alpha, beta, sigma) of the model;
`error`	estimation errors for the given confidence level.

Note

Translated from Matlab by David-Shaun Guay (HEC Montreal grant).

Author(s)

Bruno Remillard

References

Chapter 5 of 'Statistical Methods for Financial Engineering, B. Remillard, CRC Press, (2013).

Examples

```
data(data.vasicek)
out = est.ou(data.vasicek[,1]) #The first colum contains returns.
```

---

est.vasicek *Estimates the parameters of the Vasicek model. ~~*

Description

Estimates the parameters of the Vasicek model. dr = alpha(beta-r)dt + sigma dW,
with market price of risk q(r) = q1+q2 r. The time scale is in years and the units are percentages.

Usage

```
est.vasicek(data, method = "Hessian", days = 360, significanceLevel = 0.95)
```

Arguments

`data`	c(R,tau) (n x 2), with R: annual bonds yields in percentage, and tau: maturities in years;
`method`	'Hessian' (default), 'num';
`days`	number of days per year (default: 360);
`significanceLevel`	95%(default)

Value

`theta`	parameters (alpha, beta, sigma, q1,q2) of the model;
`error`	estimation errors for the given confidence level;
`rimp`	implied spot rate.

Note

Translated from Matlab by David-Shaun Guay (HEC Montreal grant).

Author(s)

Bruno Remillard

References

Chapter 5 of 'Statistical Methods for Financial Engineering, B. Remillard, CRC Press, (2013).

Examples

```
data(data.vasicek)
out = est.vasicek(data.vasicek)
```

`get.cir.param` *Computes the terms A and B for the price of a zero-coupon bond under the CIR model.*

Description

Computes the terms A and B for the price of a zero-coupon bond under the CIR model.

Usage

```
get.cir.param(param, tau, scalingFact = 1)
```

Arguments

`param`	Parameters of the CIR model: alpha,beta,sigma,q1,q2.
`tau`	Vector of maturities.
`scalingFact`	Scaling factor (default =1).

Value

`A`	See formula in the book.
`B`	See formula in the book.

Note

Translated from Matlab by David-Shaun Guay (HEC Montreal grant).

Author(s)

Bruno Remillard

References

Chapter 5 of 'Statistical Methods for Financial Engineering, B. Remillard, CRC Press, (2013).

Examples

```
params <- get.cir.param( c(0.3,2.55,0.365,0.3,0), 1)
```

---

get.vasicek.param — *Computes the terms A and B for the price of a zero-coupon bond under the Vasicek model.*

Description

Computes the terms A and B for the price of a zero-coupon bond under the Vasicek model.

Usage

```
get.vasicek.param(param, tau, scalingFact = 1)
```

Arguments

`param`	Parameters of the Vasicek model: alpha,beta,sigma,q1,q2.
`tau`	Vector of maturities.
`scalingFact`	Scaling factor (default =1).

Value

`A`	See formula in the book.
`B`	See formula in the book.

Note

Translated from Matlab by David-Shaun Guay (HEC Montreal grant).

Author(s)

Bruno Remillard

References

Chapter 5 of 'Statistical Methods for Financial Engineering, B. Remillard, CRC Press, (2013).

Examples

```
params <- get.vasicek.param( c(0.3,2.55,0.365,0.3,0), 1)
```

`LogLikCIR` *Estimates the parameters of the CIR model.*

Description

Loglikelihood for the CIR model

dr = alpha(beta-r)dt + sigma sqrt(r) dW

with market price of risk q(r) = q1/sqrt(r) +q2 sqrt(r). The time scale is in years and the units are percentages.

Usage

```
LogLikCIR( theta, R, tau, days, n)
```

Arguments

`theta`	Vector of parameters: (alpha,beta,sigma,q1,q2).
`R`	Observed returns.
`tau`	Maturities.
`days`	Number of days in a year.
`n`	Length of the time series.

Value

`LL`	-1 x Log-likelihood (to be minimized).

Note

Translated from Matlab by David-Shaun Guay (HEC Montreal grant).

Author(s)

Bruno Remillard

References

Chapter 5 of 'Statistical Methods for Financial Engineering, B. Remillard, CRC Press, (2013).

`LogLikFeller` *Estimates the parameters of the Feller process.*

Description

Loglikelihood for the CIR model

dr = alpha(beta-r)dt + sigma sqrt(r) dW.

The time scale is in years and the units are percentages.

Usage

```
LogLikFeller( theta, R, days, n)
```

Arguments

`theta`	Vector of parameters: (alpha,beta,sigma,q1,q2).
`R`	Observed returns.
`days`	Number of days in a year.
`n`	Length of the time series.

Value

`LL`	-1 x Log-likelihood (to be minimized).

Note

Translated from Matlab by David-Shaun Guay (HEC Montreal grant).

Author(s)

Bruno Remillard

References

Chapter 5 of 'Statistical Methods for Financial Engineering, B. Remillard, CRC Press, (2013).

`LogLikOU` *Estimates the parameters of the Ornstein-Uhlenbeck process.*

Description

Loglikelihood for the OU model

dr = alpha(beta-r)dt + sigma dW.

The time scale is in years and the units are percentages.

Usage

```
LogLikOU( theta, R, days, n)
```

Arguments

`theta`	Vector of parameters: (alpha,beta,sigma,q1,q2).
`R`	Observed returns.
`days`	Number of days in a year.
`n`	Length of the time series.

Value

`LL`	-1 x Log-likelihood (to be minimized).

Note

Translated from Matlab by David-Shaun Guay (HEC Montreal grant).

Author(s)

Bruno Remillard

References

Chapter 5 of 'Statistical Methods for Financial Engineering, B. Remillard, CRC Press, (2013).

`LogLikVasicek` *Estimates the parameters of the Vasicek model.*

Description

Loglikelihood for the Vasicek model

dr = alpha(beta-r)dt + sigma dW

with market price of risk q(r) = q1 +q2 r. The time scale is in years and the units are percentages.

Usage

```
LogLikVasicek( theta, R, tau, days, n)
```

Arguments

`theta`	Vector of parameters: (alpha,beta,sigma,q1,q2).
`R`	Observed returns.
`tau`	Maturities.
`days`	Number of days in a year.
`n`	Length of the time series.

Value

`LL`	-1 x Log-likelihood (to be minimized).

Note

Translated from Matlab by David-Shaun Guay (HEC Montreal grant).

Author(s)

Bruno Remillard

References

Chapter 5 of 'Statistical Methods for Financial Engineering, B. Remillard, CRC Press, (2013).

num.jacobian — *Compute the symmetric numerical first order derivatives of a multivariate function.*

Description

Compute the symmetric numerical first order derivatives of a multivariate function.

Usage

```
num.jacobian(fct_handle, x, prec)
```

Arguments

`fct_handle`	Name of a function returning a N x 1 vector.
`x`	Point (d x 1) of evaluation at which the derivatives will be computed.
`prec`	Percentage of +\- around x (in fraction).

Value

`J`	Derivatives (N x d)

Note

Translated from Matlab by David-Shaun Guay (HEC Montreal grant).

Author(s)

Bruno Remillard

References

Appendix B of 'Statistical Methods for Financial Engineering, B. Remillard, CRC Press, (2013).

Examples

```
data(data.cir)
out = est.cir(data.cir,method='num')
```

sim.cir *Simulates the Feller process.*

Description

Simulates the Feller process

dr = alpha(beta-r)dt + sigma sqrt(r) dW.

Usage

```
sim.cir(alpha, beta, sigma, r0, n, h)
```

Arguments

alpha	Mean-reversion parameter.
beta	Long term mean.
sigma	Volatility parameter.
r0	Initial rate value.
n	Number of periods.
h	Time between observations.

Value

r	Simulated annual rate in percent.

Note

Translated from Matlab by David-Shaun Guay (HEC Montreal grant).

Author(s)

Bruno Remillard

References

Chapter 5 of 'Statistical Methods for Financial Engineering, B. Remillard, CRC Press, (2013).

Examples

```
r = sim.cir(0.5,2.55,0.365,2.55,720,1/360)
```

`sim.n.chi2` *Simulates a non-central chi-square variable.*

Description

Simulates a non-central chi-square variable with parameters nu (degrees of freedom) and lambda (non-centrality).

Usage

```
sim.n.chi2(nu, lambda)
```

Arguments

`nu`	Degrees of freedom.
`lambda`	Non centrality parameter.

Value

`x`	Generated random variable.

Note

Translated from Matlab by David-Shaun Guay (HEC Montreal grant).

Author(s)

Bruno Remillard

References

Chapter 5 of 'Statistical Methods for Financial Engineering, B. Remillard, CRC Press, (2013).

Examples

```
x = sim.n.chi2(10,4.5)
```

`sim.vasicek` *Simulates the Ornstein-Uhlenbeck process.*

Description

Simulates the Ornstein-Uhlenbeck process

dr = alpha(beta-r)dt + sigma dW.

Usage

```
sim.vasicek(alpha, beta, sigma, r0, n, h)
```

Arguments

`alpha`	Mean-reversion parameter.
`beta`	Long term mean.
`sigma`	Volatility parameter.
`r0`	Initial rate value.
`n`	Number of periods.
`h`	Time between observations.

Value

`r`	Simulated annual rate in percent.

Note

Translated from Matlab by David-Shaun Guay (HEC Montreal grant).

Author(s)

Bruno Remillard

References

Chapter 5 of 'Statistical Methods for Financial Engineering, B. Remillard, CRC Press, (2013).

Examples

```
r = sim.vasicek(0.5,2.55,0.365,2.55,360,1/360)
```

Index

∗Topic **Bond**
bond.cir, 2
bond.vasicek, 3
∗Topic **CIR model**
bond.cir, 2
data.cir, 4
est.cir, 5
get.cir.param, 9
LogLikCIR, 11
∗Topic **Coefficients for bond pricing**
get.cir.param, 9
get.vasicek.param, 10
∗Topic **Feller process**
est.feller, 6
LogLikFeller, 12
sim.cir, 16
∗Topic **Log-likelihood**
LogLikCIR, 11
LogLikFeller, 12
LogLikOU, 13
LogLikVasicek, 14
∗Topic **MLE estimation**
est.cir, 5
est.feller, 6
est.ou, 7
est.vasicek, 8
∗Topic **Non-central chi-square**
sim.n.chi2, 17
∗Topic **Numerical derivative**
num.jacobian, 15
∗Topic **Ornstein-Uhlenbeck process**
est.ou, 7
LogLikOU, 13
sim.vasicek, 18
∗Topic **Simulation**
sim.cir, 16
sim.n.chi2, 17
sim.vasicek, 18
∗Topic **Vasicek model**
bond.vasicek, 3
data.vasicek, 5
est.vasicek, 8
get.vasicek.param, 10
LogLikVasicek, 14
∗Topic **datasets**
data.cir, 4
data.vasicek, 5

bond.cir, 2
bond.vasicek, 3

data.cir, 4
data.vasicek, 5

est.cir, 5
est.feller, 6
est.ou, 7
est.vasicek, 8

get.cir.param, 9
get.vasicek.param, 10

LogLikCIR, 11
LogLikFeller, 12
LogLikOU, 13
LogLikVasicek, 14

num.jacobian, 15

sim.cir, 16
sim.n.chi2, 17
sim.vasicek, 18