Package ‘FER’

March 5, 2021

Title Financial Engineering in R

Version 0.94

Description R implementations of standard financial engineering codes; vanilla option pricing models such as Black-Scholes, Bachelier, CEV, and SABR.

URL https://github.com/PyFE/FE-R

BugReports https://github.com/PyFE/FE-R/issues

Depends R (>= 3.3.1)

NeedsCompilation no

License GPL (>= 2)

Encoding UTF-8

LazyData true

RoxygenNote 7.1.1

Imports stats, statmod

Suggests testthat (>= 3.0.0)

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Repository CRAN

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R topics documented:

`BachelierImpvol` *Calculate Bachelier model implied volatility*

Description

Calculate Bachelier model implied volatility

Usage

```
BachelierImpvol(
  price,
  strike = forward,
  spot,
  texp = 1,
  intr = 0,
  divr = 0,
  cp = 1L,
  forward = spot * exp(-divr * texp)/df,
  df = exp(-intr * texp)
)
```

Arguments

`price`	(vector of) option price
`strike`	(vector of) strike price
`spot`	(vector of) spot price
`texp`	(vector of) time to expiry
`intr`	interest rate (domestic interest rate)
`divr`	dividend/convenience yield (foreign interest rate)
`cp`	call/put sign. `1` for call, `-1` for put.
`forward`	forward price. If given, `forward` overrides `spot`
`df`	discount factor. If given, `df` overrides `intr`

Value

Bachelier implied volatility

References

Choi, J., Kim, K., & Kwak, M. (2009). Numerical Approximation of the Implied Volatility Under Arithmetic Brownian Motion. Applied Mathematical Finance, 16(3), 261-268. doi: 10.1080/13504860802583436

See Also

BachelierPrice

Examples

```
spot <- 100
strike <- 100
texp <- 1.2
sigma <- 20
intr <- 0.05
price <- 20
FER::BachelierImpvol(price, strike, spot, texp, intr=intr)
```

BachelierPrice *Calculate Bachelier model option price*

Description

Calculate Bachelier model option price

Usage

```
BachelierPrice(
  strike = forward,
  spot,
  texp = 1,
  sigma,
  intr = 0,
  divr = 0,
  cp = 1L,
  forward = spot * exp(-divr * texp)/df,
  df = exp(-intr * texp)
)
```

Arguments

strike	(vector of) strike price
spot	(vector of) spot price
texp	(vector of) time to expiry
sigma	(vector of) volatility

intr	interest rate (domestic interest rate)
divr	dividend/convenience yield (foreign interest rate)
cp	call/put sign. 1 for call, -1 for put.
forward	forward price. If given, forward overrides spot
df	discount factor. If given, df overrides intr

Value

option price

References

Choi, J., Kim, K., & Kwak, M. (2009). Numerical Approximation of the Implied Volatility Under Arithmetic Brownian Motion. Applied Mathematical Finance, 16(3), 261-268. doi: 10.1080/13504860802583436

See Also

BachelierImpvol

Examples

```
spot <- 100
strike <- seq(80,125,5)
texp <- 1.2
sigma <- 20
intr <- 0.05
FER::BachelierPrice(strike, spot, texp, sigma, intr=intr)
```

BlackScholesImpvol *Calculate Black-Scholes implied volatility*

Description

Calculate Black-Scholes implied volatility

Usage

```
BlackScholesImpvol(
  price,
  strike = forward,
  spot,
  texp = 1,
  intr = 0,
  divr = 0,
  cp = 1L,
```

```
  forward = spot * exp(-divr * texp)/df,
  df = exp(-intr * texp)
)
```

Arguments

`price`	(vector of) option price
`strike`	(vector of) strike price
`spot`	(vector of) spot price
`texp`	(vector of) time to expiry
`intr`	interest rate (domestic interest rate)
`divr`	dividend/convenience yield (foreign interest rate)
`cp`	call/put sign. `1` for call, `-1` for put.
`forward`	forward price. If given, `forward` overrides `spot`
`df`	discount factor. If given, `df` overrides `intr`

Value

Black-Scholes implied volatility

References

Giner, G., & Smyth, G. K. (2016). statmod: Probability Calculations for the Inverse Gaussian Distribution. The R Journal, 8(1), 339-351. doi: 10.32614/RJ2016024

See Also

`BlackScholesPrice`

Examples

```
spot <- 100
strike <- 100
texp <- 1.2
sigma <- 0.2
intr <- 0.05
price <- 20
FER::BlackScholesImpvol(price, strike, spot, texp, intr=intr)
```

BlackScholesPrice *Calculate Black-Scholes option price*

Description

Calculate Black-Scholes option price

Usage

```
BlackScholesPrice(
  strike = forward,
  spot,
  texp = 1,
  sigma,
  intr = 0,
  divr = 0,
  cp = 1L,
  forward = spot * exp(-divr * texp)/df,
  df = exp(-intr * texp)
)
```

Arguments

`strike`	(vector of) strike price
`spot`	(vector of) spot price
`texp`	(vector of) time to expiry
`sigma`	(vector of) volatility
`intr`	interest rate (domestic interest rate)
`divr`	dividend/convenience yield (foreign interest rate)
`cp`	call/put sign. `1` for call, `-1` for put.
`forward`	forward price. If given, `forward` overrides `spot`
`df`	discount factor. If given, `df` overrides `intr`

Value

option price

References

Black, F., & Scholes, M. (1973). The Pricing of Options and Corporate Liabilities. Journal of Political Economy, 81(3), 637-654. doi: 10.1086/260062

Black, F. (1976). The pricing of commodity contracts. Journal of Financial Economics, 3(1), 167-179. doi: 10.1016/0304405X(76)900246

https://en.wikipedia.org/wiki/Black-Scholes_model

See Also

BlackScholesImpvol

Examples

```
spot <- 100
strike <- seq(80,125,5)
texp <- 1.2
sigma <- 0.2
intr <- 0.05
FER::BlackScholesPrice(strike, spot, texp, sigma, intr=intr)
```

CevMassZero *Calculate the mass at zero under the CEV model*

Description

Calculate the mass at zero under the CEV model

Usage

```
CevMassZero(
  spot,
  texp = 1,
  sigma,
  beta = 0.5,
  intr = 0,
  divr = 0,
  forward = spot * exp(-divr * texp)/df,
  df = exp(-intr * texp)
)
```

Arguments

spot	(vector of) spot price
texp	(vector of) time to expiry
sigma	(vector of) volatility
beta	beta
intr	interest rate
divr	dividend rate
forward	forward price. If given, `forward` overrides `spot`
df	discount factor. If given, `df` overrides `intr`

Value

mass at zero

Examples

```
spot <- 100
texp <- 1.2
beta <- 0.5
sigma <- 2
FER::CevMassZero(spot, texp, sigma, beta)
```

CevPrice — *Calculate the constant elasticity of variance (CEV) model option price*

Description

Calculate the constant elasticity of variance (CEV) model option price

Usage

```
CevPrice(
  strike = forward,
  spot,
  texp = 1,
  sigma,
  beta = 0.5,
  intr = 0,
  divr = 0,
  cp = 1L,
  forward = spot * exp(-divr * texp)/df,
  df = exp(-intr * texp)
)
```

Arguments

`strike`	(vector of) strike price
`spot`	(vector of) spot price
`texp`	(vector of) time to expiry
`sigma`	(vector of) volatility
`beta`	elasticity parameter
`intr`	interest rate (domestic interest rate)
`divr`	dividend/convenience yield (foreign interest rate)
`cp`	call/put sign. `1` for call, `-1` for put.
`forward`	forward price. If given, `forward` overrides `spot`
`df`	discount factor. If given, `df` overrides `intr`

Value

option price

References

Schroder, M. (1989). Computing the constant elasticity of variance option pricing formula. Journal of Finance, 44(1), 211-219. doi: 10.1111/j.15406261.1989.tb02414.x

Examples

```
spot <- 100
strike <- seq(80,125,5)
texp <- 1.2
beta <- 0.5
sigma <- 2
FER::CevPrice(strike, spot, texp, sigma, beta)
```

Nsvh1Choi2019 — *Calculate the option price under the NSVh model with lambda=1 (Choi et al. 2019)*

Description

Calculate the option price under the NSVh model with lambda=1 (Choi et al. 2019)

Usage

```
Nsvh1Choi2019(
  strike = forward,
  spot,
  texp = 1,
  sigma,
  vov = 0,
  rho = 0,
  intr = 0,
  divr = 0,
  cp = 1L,
  forward = spot * exp(-divr * texp)/df,
  df = exp(-intr * texp)
)
```

Arguments

`strike`	(vector of) strike price
`spot`	(vector of) spot price
`texp`	(vector of) time to expiry

sigma	(vector of) volatility
vov	(vector of) vol-of-vol
rho	(vector of) correlation
intr	interest rate
divr	dividend rate
cp	call/put sign. 1 (default) for call price, -1 for put price, NULL for Bachelier volatility
forward	forward price. If given, forward overrides spot
df	discount factor. If given, df overrides intr

Value

BS volatility or option price based on cp

References

Choi, J., Liu, C., & Seo, B. K. (2019). Hyperbolic normal stochastic volatility model. Journal of Futures Markets, 39(2), 186–204. doi: 10.1002/fut.21967

Examples

```
spot <- 100
strike <- seq(80,125,5)
texp <- 1.2
sigma <- 20
vov <- 0.2
rho <- -0.5
strike <- seq(0.1, 2, 0.1)

FER::Nsvh1Choi2019(strike, spot, texp, sigma, vov, rho)
```

SabrHagan2002 — *Calculate the equivalent BS volatility (Hagan et al. 2002) for the Stochatic-Alpha-Beta-Rho (SABR) model*

Description

Calculate the equivalent BS volatility (Hagan et al. 2002) for the Stochatic-Alpha-Beta-Rho (SABR) model

Usage

```
SabrHagan2002(
  strike = forward,
  spot,
  texp = 1,
  sigma,
  vov = 0,
  rho = 0,
  beta = 1,
  intr = 0,
  divr = 0,
  cp = NULL,
  forward = spot * exp(-divr * texp)/df,
  df = exp(-intr * texp)
)
```

Arguments

`strike`	(vector of) strike price
`spot`	(vector of) spot price
`texp`	(vector of) time to expiry
`sigma`	(vector of) volatility
`vov`	(vector of) vol-of-vol
`rho`	(vector of) correlation
`beta`	(vector of) beta
`intr`	interest rate (domestic interest rate)
`divr`	convenience rate (foreign interest rate)
`cp`	call/put sign. `NULL` for BS vol (default), `1` for call price, `-1` for put price.
`forward`	forward price. If given, `forward` overrides `spot`
`df`	discount factor. If given, `df` overrides `intr`

Value

BS volatility or option price based on `cp`

References

Hagan, P. S., Kumar, D., Lesniewski, A. S., & Woodward, D. E. (2002). Managing Smile Risk. Wilmott, September, 84-108.

Examples

```
sigma <- 0.25
vov <- 0.3
rho <- -0.8
beta <- 0.3
```

```
texp <- 10
strike <- seq(0.1, 2, 0.1)
FER::SabrHagan2002(strike, 1, texp, sigma, vov, rho, beta)
FER::SabrHagan2002(strike, 1, texp, sigma, vov, rho, beta, cp=1)
```

`SpreadBachelier` *Spread option under the Bachelier model*

Description

The payout of the spread option is `max(S1_T -S2_T -K,0)` where `S1_T` and `S2_T` are the prices at expiry `T` of assets 1 and 2 respectively and `K` is the strike price.

Usage

```
SpreadBachelier(
  strike = 0,
  spot1,
  spot2,
  texp = 1,
  sigma1,
  sigma2,
  corr,
  intr = 0,
  divr1 = 0,
  divr2 = 0,
  cp = 1L,
  forward1 = spot1 * exp(-divr1 * texp)/df,
  forward2 = spot2 * exp(-divr2 * texp)/df,
  df = exp(-intr * texp)
)
```

Arguments

`strike`	(vector of) strike price
`spot1`	(vector of) spot price of asset 1
`spot2`	(vector of) spot price of asset 2
`texp`	(vector of) time to expiry
`sigma1`	(vector of) Bachelier volatility of asset 1
`sigma2`	(vector of) Bachelier volatility of asset 2
`corr`	correlation
`intr`	interest rate
`divr1`	dividend rate of asset 1
`divr2`	dividend rate of asset 2

cp	call/put sign. 1 for call, -1 for put.
forward1	forward price of asset 1. If given, overrides spot1
forward2	forward price of asset 2. If given, overrides spot2
df	discount factor. If given, df overrides intr

Value

option price

Examples

```
FER::SpreadBachelier((-2:2)*10, 100, 120, 1.3, 20, 36, -0.5)
```

SpreadBjerksund2014 *Spread option pricing method by Bjerksund & Stensland (2014)*

Description

The payout of the spread option is max(S1_T -S2_T -K,0) where S1_T and S2_T are the prices at expiry T of assets 1 and 2 respectively and K is the strike price.

Usage

```
SpreadBjerksund2014(
  strike = 0,
  spot1,
  spot2,
  texp = 1,
  sigma1,
  sigma2,
  corr,
  intr = 0,
  divr1 = 0,
  divr2 = 0,
  cp = 1L,
  forward1 = spot1 * exp(-divr1 * texp)/df,
  forward2 = spot2 * exp(-divr2 * texp)/df,
  df = exp(-intr * texp)
)
```

Arguments

strike	(vector of) strike price
spot1	(vector of) spot price of asset 1
spot2	(vector of) spot price of asset 2
texp	(vector of) time to expiry
sigma1	(vector of) volatility of asset 1
sigma2	(vector of) volatility of asset 2
corr	correlation
intr	interest rate
divr1	dividend rate of asset 1
divr2	dividend rate of asset 2
cp	call/put sign. 1 for call, -1 for put.
forward1	forward price of asset 1. If given, overrides spot1
forward2	forward price of asset 2. If given, overrides spot2
df	discount factor. If given, df overrides intr

Value

option price

References

Bjerksund, P., & Stensland, G. (2014). Closed form spread option valuation. Quantitative Finance, 14(10), 1785–1794. doi: 10.1080/14697688.2011.617775

Examples

```
FER::SpreadBjerksund2014((-2:2)*10, 100, 120, 1.3, 0.2, 0.3, -0.5)
```

SpreadKirk *Kirk's approximation for spread option*

Description

The payout of the spread option is max(S1_T -S2_T -K,0) where S1_T and S2_T are the prices at expiry T of assets 1 and 2 respectively and K is the strike price.

Usage

```
SpreadKirk(
  strike = 0,
  spot1,
  spot2,
  texp = 1,
  sigma1,
  sigma2,
  corr,
  intr = 0,
  divr1 = 0,
  divr2 = 0,
  cp = 1L,
  forward1 = spot1 * exp(-divr1 * texp)/df,
  forward2 = spot2 * exp(-divr2 * texp)/df,
  df = exp(-intr * texp)
)
```

Arguments

`strike`	(vector of) strike price
`spot1`	(vector of) spot price of asset 1
`spot2`	(vector of) spot price of asset 2
`texp`	(vector of) time to expiry
`sigma1`	(vector of) volatility of asset 1
`sigma2`	(vector of) volatility of asset 2
`corr`	correlation
`intr`	interest rate
`divr1`	dividend rate of asset 1
`divr2`	dividend rate of asset 2
`cp`	call/put sign. `1` for call, `-1` for put.
`forward1`	forward price of asset 1. If given, overrides `spot1`
`forward2`	forward price of asset 2. If given, overrides `spot2`
`df`	discount factor. If given, `df` overrides `intr`

Value

option price

References

Kirk, E. (1995). Correlation in the energy markets. In Managing Energy Price Risk (First, pp. 71–78). Risk Publications.

See Also

SwitchMargrabe

Examples

```
FER::SpreadKirk((-2:2)*10, 100, 120, 1.3, 0.2, 0.3, -0.5)
```

SwitchMargrabe *Margrabe's formula for exhange option price*

Description

The payout of the exchange option is `max(S1_T -S2_T,0)` where `S1_T` and `S2_T` are the prices at expiry `T` of assets 1 and 2 respectively.

Usage

```
SwitchMargrabe(
  spot1,
  spot2,
  texp = 1,
  sigma1,
  sigma2,
  corr,
  intr = 0,
  divr1 = 0,
  divr2 = 0,
  cp = 1L,
  forward1 = spot1 * exp(-divr1 * texp)/df,
  forward2 = spot2 * exp(-divr2 * texp)/df,
  df = exp(-intr * texp)
)
```

Arguments

`spot1`	(vector of) spot price of asset 1
`spot2`	(vector of) spot price of asset 2
`texp`	(vector of) time to expiry
`sigma1`	(vector of) volatility of asset 1
`sigma2`	(vector of) volatility of asset 2
`corr`	correlation
`intr`	interest rate
`divr1`	dividend rate of asset 1

divr2	dividend rate of asset 2
cp	call/put sign. 1 for call, -1 for put.
forward1	forward price of asset 1. If given, overrides spot1
forward2	forward price of asset 2. If given, overrides spot2
df	discount factor. If given, df overrides intr

Value

option price

References

Margrabe, W. (1978). The value of an option to exchange one asset for another. The Journal of Finance, 33(1), 177–186.

See Also

SpreadKirk

Examples

```
FER::SwitchMargrabe(100, 120, 1.3, 0.2, 0.3, -0.5)
```

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