

Package ‘FER’

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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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BachelierImpvol	<i>Calculate Bachelier model implied volatility</i>
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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](https://doi.org/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](https://doi.org/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	<i>Calculate Black-Scholes implied volatility</i>
--------------------	---

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](https://doi.org/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	<i>Calculate Black-Scholes option price</i>
-------------------	---

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](https://doi.org/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://doi.org/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](https://doi.org/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](https://doi.org/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 Stochastic-Alpha-Beta-Rho (SABR) model

Description

Calculate the equivalent BS volatility (Hagan et al. 2002) for the Stochastic-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)
```

SpreadBjerk Sund2014 *Spread option pricing method by Bjerk Sund & 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

```
SpreadBjerk Sund2014(
  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

Bjerk Sund, P., & Stensland, G. (2014). Closed form spread option valuation. *Quantitative Finance*, 14(10), 1785–1794. doi: [10.1080/14697688.2011.617775](https://doi.org/10.1080/14697688.2011.617775)

Examples

```
FER::SpreadBjerk Sund2014((-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 exchange 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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