Package ‘OptionPricing’

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OptionPricing-package Option Pricing and Greeks Estimation for Asian and European Options

Description

The Price, Delta and Gamma of European and Asian Options under Geometric Brownian Motion are calculated using the Black-Scholes formula and Efficient Monte Carlo and Randomized Quasi Monte Carlo Algorithms.
The OptionPricing package calculates the Price, Delta and Gamma for European options using the Black-Scholes formula (see `bs_ec`). The price, Delta and Gamma for Asian call options under geometric Brownian motion are calculated using a very efficient Monte Carlo and randomized quasi-Monte Carlo algorithm (see `asiancall`). The function `asiancall_applord` implements a high-quality approximation for the price of an Asian option.

**Author(s)**

Kemal Dingec, Wolfgang Hormann

**Examples**

```r
# standard settings for an efficient simulation using QMC and variance reduction
AsianCall(T=1,d=12,K=100,r=0.05,sigma=0.2,S0=100,method=c("best"),
sampling=c("QMC"),metpar=list(maxiter=100,tol=1.e-14,cvmethod="splitting"),
sampar=list(nout=50,n=2039,a=1487,baker=TRUE,genmethod="pca"))

# Calculation of the Price of an Asian option using a good approximation
AsianCall_ApplOrd(T = 1, d = 12, K = 100, r = 0.05, sigma = 0.2, S0 = 100)

# standard settings for an efficient simulation using MC and variance reduction
AsianCall(T=1,d=12,K=170,r=0.05,sigma=0.2,S0=100,method="best",
sampling="MC",metpar=list(maxiter=100,tol=1.e-14,np=1000),
sampar=list(n=10^5))

# Calculation of the approximate price, a bit different to the above result
AsianCall_ApplOrd(T = 1, d = 12, K = 170, r = 0.05, sigma = 0.2, S0 = 100)

# Calculation of the Price of an Asian option using a good approximation
AsianCall_ApplOrd(T = 1, d = 12, K = 100, r = 0.05, sigma = 0.2, S0 = 100)

# Price, Delta and Gamma of European options using Black-Scholes
BS_EC(K=100, r = 0.05, sigma = 0.2, T = 0.25, S0 = 100)
BS_EP(K=100, r = 0.05, sigma = 0.2, T = 0.25, S0 = 100)
```

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**AsianCall**

*Calculates the Price, Delta and Gamma of an Asian Option*
Description

Prices arithmetic average Asian Call options under geometric Brownian motion. It also estimates the sensitivities Delta and Gamma.

Usage

AsianCall(T=1,d=12,K=100,r=0.05,sigma=0.2,S0=100,method=c("best","naive"),
    sampling=c("QMC","MC"),
    metpar=list(maxiter=100,tol=1.e-14,cvmethod="splitting"),
    sampar=list(nout=50,seq.type="korobov",n=2039,a=1487,
        baker=TRUE,genmethod="pca"))

Arguments

T    time to maturity (in years)
d    number of control points
K    strike price
r    risk free interest rate
sigma    volatility
S0    starting stockprice
method    selects the simulation method;
method "best" uses a variance reduction method based on effective control
variates and conditional Monte Carlo and is very effective.
method "naive" is mainly provided for comparison purposes.
sampling    sampling QMC uses the Quasi Monte Carlo method Korobov lattice for the simu-
     lation,
sampling MC uses standard Monte Carlo for the simulation.
metpar    list holding extra parameters related to the simulation method
For method="best":
    maxiter= maximal no of iterations for Newton method
tol= error tolerance for Newton method
for sampling="QMC":
    cvmethod=c("splitting","direct") NOT necessary for method = "naive"
    "splitting" ... estimates CV coefficients using lm with bootstrap
    "direct" ... estimates CV coefficients using lm and the full sample
for sampling="MC":
    np ... sample size for pilot run for CV; NOT necessary for method = "naive"
sampar    list holding several parameters related to the sampling method;
for sampling="MC" the list sampar only contains the total samplesize n;
for sampling="QMC" the list sampar contains the elements:
    nout  number of independent "randomized" copies of the Korobov lattice
    n  number of points of the Korobov lattice
AsianCall

a important constant for the construction of the Korobov lattice
baker TRUE/FALSE, indicates if Baker transform should be used for making the
integrand periodic
genmethod = c("pca", "std","pcamain","lt","ltpca"),
note that for method="naive" only genmethod=c("pca", "std") can be
used.

Details

Method best (see the reference Dingec and Hormann below) is a very efficient simulation algorithm
using multiple Control Variates and conditional MonteCarlo to calculate the the price, delta and
gamma of Asian call options under geometric Brownian motion. It is especially effective when
QMC is selected as sampling method. As QMC method Korobov Lattice rules are used. For good
parameter values see Table 1 of (L’Ecuyer, Lemieux).

Value

returns a matrix holding the price and greeks. The estimated Asian Call price and its estimated
delta and gamma form the first column vector, the respective 95 percent error bounds are given in
the second column.

Author(s)

Kemal Dingec, Wolfgang Hormann

References

K. D. Dingec and W. Hormann. Improved Monte Carlo and Quasi-Monte Carlo Methods for the
Price and the Greeks of Asian Options, Proceedings of the 2014 Winter Simulation Conference A.
Tolk, S. D. Diallo, I. O. Ryzhov, L. Yilmaz, S. Buckley, and J. A. Miller, eds.

46 (9): 1214-1235.

See Also

OptionPricing-package
Examples

# standard settings for an efficient simulation using QMC and variance reduction
AsianCall(t=1,d=12,K=100,r=0.05,sigma=0.2,S0=100,method="best",
    sampling="QMC",metpar=list(maxiter=100, tol=1.e-14,cvmethod="splitting"),
    sampar=list(nout=50,n=2039,a=1487,baker=TRUE,genmethod="pca"))

# efficient Monte Carlo version of the above simulation
AsianCall(t=1,d=12,K=100,r=0.05,sigma=0.2,S0=100,method="best",
    sampling="MC",metpar=list(maxiter=100, tol=1.e-14,np=1000),
    sampar=list(n=10^5))

# simple QMC version without variance reduction
AsianCall(t=1,d=12,K=100,r=0.05,sigma=0.2,S0=100,method="naive",
    sampling="QMC",
    sampar=list(nout=50,n=2039,a=1487,baker=TRUE,genmethod="pca"))

# naive Monte Carlo version
AsianCall(t=1,d=12,K=100,r=0.05,sigma=0.2,S0=100,method="naive",
    sampling="MC",sampar=list(n=10^5))

AsianCall_AppLord

### Description

The price of an arithmetic average Asian option is computed using the approximation method of Lord.

### Usage

AsianCall_AppLord(T=1, d=12, K=100, r=0.05, sigma=0.1, S0=100, all=TRUE)

#### Arguments

- **T**
  - T time to maturity (in years)
- **d**
  - d number of controll points
- **K**
  - K strike price
- **r**
  - r risk free interest rate
- **sigma**
  - sigma volatility (yearly)
- **S0**
  - S0 starting stockprice
- **all**
  - all TRUE means that the full Asian Call option price is approximated
Details
AsianCall_Applord() uses a sophisticated approximation of Lord (2006).

Value
returns the approximate price.

Author(s)
Kemal Dingec, Wolfgang Hormann

References

See Also
OptionPricing-package

Examples
AsianCall_Applord(T = 1, d = 12, K = 100, r = 0.05, sigma = 0.25, S0 = 100, all = TRUE)

bs_ec
Black-Scholes Formula for European Call and Put

Description
Calculates the Price, Delta and Gamma of an European Call or Put option using the Black-Scholes formula.

Usage
BS_EC( T = 0.25, K = 100, r = 0.05, sigma = 0.2, S0 = 100 )
BS_EP( T = 0.25, K = 100, r = 0.05, sigma = 0.2, S0 = 100 )

Arguments
T time to maturity (in years)
K Strike Price
r risk-free interest rate
sigma yearly volatility
S0 Starting Stock Price
Value
Returns a vector containing the option price, Delta and Gamma

Author(s)
Wolfgang Hormann

See Also
OptionPricing-package

Examples
BS_EC(K=100, r = 0.05, sigma = 0.2, T = 0.25, S0 = 100)
BS_EP(K=100, r = 0.05, sigma = 0.2, T = 0.25, S0 = 100)
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