ENERGY POWER RISK

ENERGY POWER RISK: DERIVATIVES, COMPUTATION AND OPTIMIZATION

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To Kathy, Matthew, Claire and Rachel

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Notations

The notation used is as follows:

GBM	Geometric Brownian motion
BM	Brownian motion
W_t	Brownian motion at time t – the term may be nonzero
ρ	The correlation coefficient
$E[x]$	The expectation value of X
$Var[X]$	The variance of X
$Cov[X, Y]$	The covariance between X and Y
$Cov[X]$	The covariance between the variates contained in the vector X
σ	The volatility. Since assets are assumed to follow GBM, it is computed as the *annualized* standard deviation of the n continuously compounded returns
$N_1(a)$	The univariate cumulative normal distribution function. It gives the cumulative probability, in a standardized univariate normal distribution, that the variable x_1 satisfied $x_1 \leq a$
$N_2(a, b, \rho)$	The bivariate cumulative normal distribution. It gives the cumulative probability, in a standardized bivariate normal distribution, that the variables x_1 and x_2 satisfy $x_1 \leq a$ and $x_2 \leq b$ when with correlation coefficient between x_1 and x_2 is ρ
r	The risk free interest rate
q	The continuously compounded dividend yield
S_{it}	The ith asset price at time t
I_{nn}	The n by n unit matrix
$\Lambda(\mu, \sigma^2)$	A lognormal distribution with parameters μ and σ^2. If $y = \log(x)$ and $y \sim N\left(\mu, \sigma^2\right)$, then the distribution for $x = e^y$ is $x \sim \Lambda(\mu, \sigma^2)$. We have $E[x] = \exp\left(\mu + (\sigma^2/2)\right)$ and $Var[x] = \exp\left(2\mu + \sigma^2\right)\left(\exp\left(\sigma^2\right) - 1\right)$
$\log(x)$	The natural logarithm of x
$N(a, b)$	Normal distribution, with mean a and variance b
dW_t	A normal variate (sampled at time t) from the distribution $N(0, dt)$, where dt specified time interval e.g., $dx = \mu dt + dW_t$
dZ_t	A normal variate (sampled at time t) from the distribution $N(0, 1)$. Note: The variate $d\psi = \sqrt{dt}\, dZ_t$ has the same distribution as dW_t

IID	Independently and identically distributed
$\mathcal{U}(a, b)$	The uniform distribution, with lower limit a and upper limit b
$\|x\|$	The absolute value of the variable x
PDF	The probability density function of a given distribution
$x \wedge y$	The minimum of x and y, that is, $\min(x, y)$

Preface

The aim of this book is to provide readers with sufficient knowledge to understand and create quantitative models for energy/power risk and derivative valuations. The topics covered include the mathematics of stochastic processes, assets optimization, Markowitz portfolio optimization, derivative valuation, and financial engineering using C++. One could write a separate book on each of these subjects, and therefore of necessity their coverage in this book could be considered to be an introduction. However, I trust that readers will find the book a useful reference and building block for their projects.

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