OPTION VALUATION ON ENERGETICS
Petroleum, Electricity, and Natural Gas

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Abstract

In the classical formula of options prining of Black-Scholes it is supposed that the underlying asset has a dynamic behaviour related to the differential stochastic linear homogeneous equation

$$dS_t = \mu S_t \, dt + \sigma \, S_t \, dB_t , \tag{1}$$

where μ y σ are constants and $\{B_t\}_{t \geq 0}$ is a Unidimensional Standard Brownian Motion. The solution process of the equation (1) is known as Geometric Brownian Motion and the parameters μ y σ respectively represent, the annual return rate related to the price of the asset and the annual standard deviation of the returns commonly known as volatility.

The implementation of a Geometric Brownian Motion to model the dynamic behaviour of prices in energetics such as Petroleum, Electricity, Natural Gas, and some metals like Aluminium is a non appropriate choice because unlike the price of the shares, these commodities present marked long term characteristics that make unrealistic its modelation with this process.

First of all, the mean on the long run of a Geometric Brownian Motion increases exponentially and consequently, the future value of the process depends only on the initial value observed without relating it in any way with long term trends which are observed in the market. Secondly, the variance of a Geometric Brownian Motion grows exponentially and the logarithmic returns increase in a linear way, in other words, the volatility of the asset that is modeled with such process is not bounded; on the other hand, there is a clear evidence that for the case of some energetics, the expected value and price variation tend to correct themselves to achieve a long term distribution, which makes one assume that this model is once again inappropriate

According to the literature, an alternative process that exhibits the previously mentioned long term characteristics and which can be useful to model daily price dynamics of these energetics is known as Mean Reverting Process, whose dynamic is associated to the Stochastic Differencial Equation given by

$$dS_t = \alpha \left(\mu - S_t \right) dt + \sigma \, S_t^{\gamma} \, dB_t \, ; \quad \gamma = 0{,}1 \, , \tag{2}$$

where α, μ y σ are constant and $\{B_t\}_{t \geq 0}$ is a Unidimensional Standard Brownian Motion.

Then, if there are mistakes in the specification of the model for daily prices, the valuation of options over these commodities considering the Black-Scholes formula is yet more inappropriate. In this light, this argument supports this work.

Bearing in mind that a closed formula for the valuation of options has not been yet developed over energetics that can be modeled as a Mean Reverting Process, it is necessary to appeal to numerical methods that guarantee an adequate convergence to the boundary value problem associated to the value of the option being practical enough to be implemented in a computational way.

In this work it is presented two alternative numerical methods that can be useful for the valuation of options over some energetics whose daily price dynamics can be modeled as a Mean Reverting Process of one factor. The first is a recombination of binomial multiplicative trees in which the transition probabilities connected to the cualitative change of the prices in an discrete time instant are deducted.

The second is an explicit finite method of differences which presents a modification in the branching process due to a variable transformation which forces to restructure the set conditions in such a way that the sufficient conditions to guarantee its convergence are conserved.

In both cases it is neccesary to calculate the transition probabilities in terms of the paremeters α, μ y σ of the Stochastic Differencial Equation (2), which should be previously estimated using historical data

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