The choice of stochastic process of oil prices

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Abstract

Oil is a commodity that has very important role in a modern economy, generating the interest for its price behavior. Furthermore, there are many assets – oil derivatives, production assets, financial derivatives, contracts, etc. – whose values are linked to this commodity performance. In this sense, the choice of stochastic processes in order to represents the oil prices behavior will have significant impact not only in the value of this assets, but also in there optimal investment decision rules. Considering the different models presented by several previous works, the aim of this study is to evaluate, using statistical tools which model could be more appropriate among existing propositions.

Introduction

In the asset valuation it is necessary to deal with several source of uncertainty, caused by the fluctuation in the demand, product prices, costs, investment and so on. Particularly, when evaluating financial derivatives (options, forwards contracts, future prices and swaps) or projects using real options methods, it is usual to deal with these uncertainty using stochastic processes. Stochastic processes can be described as a sequence of results of random variables that move discretely or continuous on the time.

Considering that oil is the most important commodity in the world, its prices, derivatives and production assets, are the focus of several studies in the last four decades. Similarly, the pioneer works in financial options and real options (Black & Scholes, 1973; Cox, Ross & Rubinstein, 1979; Brennan & Schwartz, 1985; McDonald & Siegel, 1985 and 1986). Paddock, Siegel, & Smith (1988) evaluate the investment in Offshore Petroleum Lease considering that commodity prices follows Geometric Brownian Motions (GBM). Other works (Gibson & Schwartz, 1990; Dixit & Pindyck, 1994; Schwartz, 1997) argue that some commodities, in special commercial commodities such as oil, Mean Reversal Models (MRM) would be more appropriated assuming that in the short run prices present a random behavior, but in the long run – based in the microeconomics theory – they converge to equilibrium level reflecting production marginal cost. In the recent decades, some authors propose models of multiple factors that combining GBM, MRM and Poisson process (Schwartz, 1997; Pindyck, 1999; Schwartz & Smith, 2000; Cortazar &

Schwartz, 2003), arguing that such combinations would generates more realistic models for oil prices behavior.

The diversity of alternatives naturally raise the question of which process might be considerate most appropriated. Several issues, such as the lifetime of the asset and the availability of information (historical prices series) can influence the choice of stochastic processes. Another important issue is the kind of model chosen for the valuation: closed formulas, Monte Carlos simulations, Binomial lattice, etc. In particular, the use of statistical methods can bring a set of relevant information in order to help to define the model that best describes the asset prices behavior.

In the literature, several statistical tools are suggested for the price behavior analyses and useful for the selection of stochastic processes. The Unit roof tests (Dickey-Fuller, Phillips-Perron, KPSS) and the variance ratio are useful for checking the prices features in favor of one or another model. The adherence measures can be used to analyses the fit of the models allowing to compare them considering information in sample and out-of-sample. In addition, we can use other tools such as Maximum likelihood Ratio and Information criteria tests (AIC, BIC, Hannan-Quinn e Schwarz information criterion) to evaluate pros and coins of the models based on the level of complexity.

The objective of this study is present the mains tools and their applications to support the selection of the stochastic processes that best represent the oil price behavior. This process of choice is very relevant to the correct evaluation of the several assets influenced by the price of oil and it can interfering not only in their values but also in the investment rule. In addition to the treatment of specific use of each tool, the study intents to delineates a routine of procedures for their combined use.

This paper is structure as follows: in the second section, bibliography revision is on applied stochastic processes to assets valuation is made; in the third section, relevant aspects in statistical tools for the choice of stochastic processes are presented; in the fourth section statistical tools are applied to support the selection of the most appropriate to describe the price behavior; in the fifth section the results are analyzed and discussed; and in the sixth section we conclude.

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