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Valuing Oil and Gas Options by Least-Squares Monte Carlo Simulation

B.J.A. Willigers, Palantir Economic Solutions Ltd., and R.B. Bratvold, University of Stavanger and IRIS

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Abstract

Least-Squares Monte Carlo simulation (LSM) is a promising new technique for valuing real options that has received little or no attention in the oil and gas industry. In this paper, we will demonstrate how LSM can handle more realistic valuation situations including the ability to (i) handle more realistic (probabilistic) price models and (ii) deal with multiple, possibly correlated, uncertain variables.

The LSM method is applied here to an economics problem faced by many operators: What is the value of a gas field given the decision to trade the gas on the spot market as opposed to selling the gas through a long-term supply contract? A company that chooses to trade gas can decide when and how much to produce and can profit from changing market conditions, as by increasing production during a high-price environment.

Three uncertainties have been modeled: the gas price, the operational costs, and the rate of production decline. Increasing profitability associated with rising hydrocarbon prices is typically partially offset by increasing expenditures. Hence the costs have been correlated with the gas price. The expectation of the remaining reserves is continuously adjusted on the basis of the performance of the field. The latter is simulated by stochastically modeling the rate of production decline.

The paper shows that a gas field that can be produced and abandoned at will has large value of flexibility. The Net Present Value of such an asset will underestimate the true economic value. A further benefit of using the real option valuation approach discussed here is that the valuation procedure produces a strategy map showing actions within the project, not just numbers.

1. Introduction

Flexibility is an important part of a firm's action but is not well modeled by traditional financial tools. Creating an effective strategy typically has two critical, but in some ways conflicting, objectives: making the most of what a company is, and preparing for what it can be (Marcus 2005). Preparing for the unknown future involves adapting to that future as it unfolds. The petroleum manager's toolkit contains many qualitative descriptions of this adaptation, all of which implicitly follow an "if/then/else" structure. For example, a petroleum manager might want to consider the value of an exploration license. Using words, she will argue that *if* the appraisal and exploration show significant potential of reserves, *then* the company should apply for a production license; otherwise (*else*) the company should refrain from doing so, because a license will not be profitable. The traditional discounted cash flow (DCF) approach cannot reflect this if/then/else structure, but real option valuation (ROV) can.

How managers cope with uncertainty is in stark contrast with how they typically model and value it. DCF is based on the unrealistic assumption that once an initial investment is made, the project will run its course without intervention. The possibility of abandoning a project in the face of adverse circumstances or expanding it in response to unanticipated demand is not considered.

ROV is a valuation and decision-support methodology that is much better aligned with the actual decision-making process. ROV allows for a systematic assessment of the choices available, the risk exposure, and the expected outcome of the known options. The method embraces the notion that the management of projects is not limited to an initial stop/go decision but actually entails a sequence of choices as additional project information becomes available. For example, if an E&P company decides not to develop an oil field today, the company may still have the opportunity to do so in the future. By paying a fixed license fee to the government, the company buys a real option: the right, but not the obligation, to make an investment and produce hydrocarbons at any time during the license term. The flexibility associated with the project translates into economic value. For example, a company can increase the chance of a positive return on an investment if an irreversible investment decision can be delayed until more information becomes available. The value in having different