

REAL OPTIONS MODELING IN THE PETROLEUM EXPLORATION AND PRODUCTION (E&P) INDUSTRY

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Overview

This study establishes a risk-neutral binomial lattice model to apply real options theory to valuation and decision-making in the petroleum exploration and production (E&P) industry.

The method is specifically applied to the switching time from primary to water flooding oil recovery.

Methods

First, West Texas Intermediate (WTI) oil price evolution from January 2, 1986 to May 28, 2010 is studied and modeled with geometric Brownian motion (GBM) and one-factor mean reversion price models. Second, production profile for primary and water flooding oil recovery for a synthetic onshore oil reservoir is generated using UTCHEM simulator. Third, the binomial lattice real options evaluation (ROE) method is established to value the project with flexibility in switching time from primary to water flooding oil recovery.

Results

1) for GBM price model, the assumptions of constant drift rate and volatility do not hold for WTI oil prices; 2) one-factor mean reversion model is better to fit WTI oil prices than GBM model; 3) the evolution of WTI oil prices in those 25 years was according to three price regimes and since 2003, the world economy has increased its tolerance to higher oil prices and to higher price fluctuation from its long run price.

Conclusions

1) The established ROE method can be used to identify the best time to switch from primary to water flooding oil recovery; 2) with one-factor mean reversion oil price model and the most updated cost data, the ROE method finds that water flooding switching time is earlier than that from traditional net present value optimizing method; 3) water flooding switching time is sensitive to oil price models and to the investment and operating costs.