

Chapter 3

Petroleum Exploration Risk in Prospect Portfolio Selection

ABSTRACT

Presented method is applied to petroleum exploration for prospect portfolio selection to achieve investment objectives controlling risk. DMAIC framework applies stochastic techniques to risk management. Optimisation resolves Efficient Frontier of portfolios for desired range of expected return with initially defined increment. Simulation measures Efficient Frontier portfolios calculating mean return, variance, standard deviation, Sharpe Ratio, and Six Sigma metrics versus pre-specified target limits. Analysis considers mean return, Six Sigma metrics and Sharpe Ratio and selects the portfolio with maximal Sharpe Ratio as initially the best portfolio. Optimisation resolves Efficient Frontier in a narrow interval with smaller increments. Simulation measures Efficient Frontier performance including mean return, variance, standard deviation, Sharpe Ratio, and Six Sigma metrics versus pre-specified target. Analysis identifies the maximal Sharpe Ratio portfolio, i.e. the best portfolio for implementation. Selected prospects in the portfolio are individual projects. So, Project Management approach is used for control.

INTRODUCTION

This chapter presents the second Portfolio Management application class of the method. It is applied in Oil and Gas Industry to manage the petroleum exploration risk in prospect portfolio selection.

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During the early 1980s, the major international oil and gas explorations globally exhibited that the average size of new discoveries was diminishing. The “High Risk / High Potential” category of exploratory prospects was showing a noticeable underperformance. For example, the major petroleum corporations, considering all the ventures that expected in average 10% probability of success, actually discovered less than 1% profitable oil and gas reserves, the sizes of which were much smaller than predicted. Factually, such explorations for new huge fields were destroying, rather than creating value. Consequently, the exploration corporate function lost credibility. This strongly recognised the need to adopt risk analysis to reduce the exploration risk, and portfolio management to improve the return on investment.

During the 1990s, many international petroleum corporations significantly improved their exploration performance by introducing risk analysis and portfolio management methodologies, in addition to new geo-technologies. As superior technologies were introduced, the petroleum industry realised that systematic procedures are crucial for better management of the exploration function. This involves structured methodologies of: i) Risk and decision analysis to reduce exploration risk; and ii) Portfolio management to optimise the allocation of exploration capital in order to increase return on investment. Contemporarily, significant work was published relating to applications of risk and decision analysis and implementation of portfolio management to petroleum explorations.

Risk and decision analysis generically applies to any type of business investment decision (Bernstein 1996). Contemporary risk models are stochastic and use Monte Carlo simulation. A comprehensive elaboration on investment risk applications of Monte Carlo simulation was published by Glasserman (2004). The focus here however is on the applications to petroleum exploration. For example, Rose (1987) elaborated on how to improve the dealing with risk and uncertainty in petroleum exploration. Capen (1992) went into detail of dealing with exploration uncertainty in petroleum exploration. MacKay (1996) presented risk management ideas for petroleum ventures. Alexander and Lohr (1998) demonstrated the lessons learned from risk analysis at the Society of Petroleum Engineers Annual Meeting. Brown and Rose (2000) discussed the petroleum exploration prospects focussing on assessment of volumes, value and chance.

Portfolio analysis applies to any type of business investment decision as well. The problem of portfolio optimisation was solved in the 1950's by

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