The University of Adelaide
Faculty of Engineering, Computer and
Mathematical Science
Australian School of Petroleum

MULTI-OBJECTIVE PORTFOLIO OPTIMISATION OF UPSTREAM PETROLEUM PROJECTS

Otto Aristeguieta
I.D. 1109860

Supervisors:

Prof. Reidar Bratvold
Prof. Steve Begg
Prof. Andrés Medaglia

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ABSTRACT

The shareholders of E&P companies evaluate the future performance of these companies in terms of multiple performance attributes. Hence, E&P decision makers have the task of allocating limited resources to available project proposals to deliver the best performance on these various attributes. Additionally, the performance of these proposals on these attributes is uncertain and the attributes of the various proposals are usually correlated. As a result of the above, the E&P portfolio optimisation decision setting is characterised by multiple attributes with uncertain future performance.

Most recent contributions in the E&P portfolio optimisation arena seek to adapt modern financial portfolio theory concepts to the E&P project portfolio selection problem. These contributions generally focus on understanding the tradeoffs between risk and return for the attribute NPV while acknowledging the presence of correlation among the assets of the portfolio. The result is usually an efficient frontier where one objective is set over the expected value of the NPV and the other is set over a risk metric calculated from the same attribute where, typically, the risk metric has a closed form solution (e.g., variance, standard deviation, semi-standard deviation). However, this methodology fails to acknowledge the presence of multiple attributes in the E&P decision setting.

To fill this gap, this thesis proposes a decision support model to optimise risk and return objectives extracted from the NPV attribute and from other financial and/or operational attributes simultaneously. The result of this approach is an approximate Pareto front that explicitly shows the tradeoffs among these objectives whilst honouring intra-project and inter-project correlations. Intra-project correlations are incorporated into the optimisation by integrating the single project models to the portfolio model to be optimised. Inter-project correlation is included by modelling of the oil price a global variable. Additionally, the model uses a multi-objective simulation-optimisation approach and hence it overcomes the need of using risk metrics with closed form solutions.

The model is applied to a set of realistic hypothetical offshore E&P projects. The results show the presence of complex relationships among the objectives in the approximate Pareto set. The ability of the method to unveil these relationships hopes to bring more insight to the decision makers and hence promote better investment decisions in the E&P industry.

STATEMENT OF ORIGINALITY

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent to this copy of my thesis, when deposited in the University Library, being made available in all forms of media, now or hereafter known.

Signed:_____ Date:_____

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LIST OF SELECTED ACRONYMS AND ABBREVIATIONS

Abex	abandonment costs
ATNCF	after tax net cash flow
Bbl	barrels
Capex	capital expenditures
DM	decision maker
E&P	downstream oil and gas exploration and production companies
E(X)	expected value of the attribute X
EconLimit	economic limit of the field
EUR	expected ultimate recovery
FixOpex	fixed operating expenditures
IntanCapex	intangible capital expenditures
M	thousand
Maxcap	maximum capacity of the production hub
MM	million
NCF	net cash flow
NPV	net present value
OOIP	original oil in place
Opex	operating expenditures
P(X>0)	probability that the attribute X will return a positive value
P10(X)	10^{th} percentile of the attribute X
P50(X)	50^{th} percentile of the attribute X
P90(X)	90^{th} percentile of the attribute X
PDF	probability density function
PSC	production sharing contract
q_t	production of the field in time t
R	reserves
ROCE	return over capital employed
SD(X)	standard deviation of the attribute X
TanCapex	tangible capital expenditure
US$	United States Dollars
VarOpex	variable operating expenditures