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Value Creation Through Portfolio Management

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In many of the mature provinces around the world the average size of potentially commercial (pre development approval) fields has fallen dramatically in recent years. For example within the UKCS the average size of a potentially commercial field is now around 30 million barrels of oil equivalent. The decline in the average size of these fields and the recent high level of volatility in both oil and gas prices has resulted in the full cycle economics of these regions becoming increasingly marginal. This, coupled with the uncertainty surrounding acquisition prices, means that robust asset valuation techniques with due consideration given to a quantitative analysis of risk is becoming increasingly pivotal to a company's ability to maximise shareholder value.

Although accurate asset valuation is crucial if companies are to remain competitive in the market place, the bigger perspective is concerned with the company's portfolio of assets. Petroleum companies constantly face decisions fraught with risk. Made in isolation, these investments will only maximise the value of individual assets. In order to balance the risk and exploit project synergies, investments and divestment decisions need to be made collectively with consideration given to the entire portfolio of assets as opposed to individual assets.

This presentation reviews the available asset valuation and decision analysis techniques, many of which have been around for over 25 years. The presentation also explains how through a combination of asset valuation techniques, Monte Carlo simulation and modern portfolio theory, both risk and return can be quantified in order to create value through active portfolio management.

Net Present Value

Within the petroleum industry net present value (NPV) is now the most widely used measure of profitability. In NPV calculations, expected future cash flows to an organisational treasury are determined and summed to yield the value of the assets. However since the flow of funds earned by the investment will occur at various points of time in the future, it becomes clear that the time value of money must be incorporated into all measures of profitability. This is achieved through the use of a discount factor. The choice of discount rate is however a controversial subject for which there is little general agreement and thus determining the appropriate discount rate is ultimately a

matter of judgement and preference. Two of the more common methods of determining the discount rate are:

- Weighted average cost of capital (WACC)
- Capital asset pricing model (CAPM)

Although the NPV is the most widely used measure of profitability, like all other measures of profitability it still possesses some fundamental weaknesses.

1. Difficulty in determining the appropriate discount rate to use for a project. The most widely accepted convention is that all projects should be evaluated using the company's weighted average cost of capital. Unfortunately this makes the assumption that all projects have the same level of risk as the company, which is clearly not the case. For example, compare a low risk pipeline investment in Western Europe with a high-risk exploration opportunity in the Far East.
2. Failure to account for the added value brought to an asset through the ability of management to react to changes in the economic climate to either capitalise on favourable opportunities or mitigate against potential losses. This is the added value of managerial flexibility.
3. Under-valuation of long-lived and strategic projects due to excessively high discount rates. The nature of the calculation of NPV dictates that projects whose lifetime exceeds a period of about 20 years are assigned little or no value beyond this point.

Although the weaknesses in the NPV method are widely known in the industry, the lack of a credible and widely accepted alternative means NPV still remains the most widely used method.

Monte Carlo Simulation

Monte Carlo simulation is a statistics-based analysis tool that yields "probability-versus-return"
relationships for key parameters, including oil and gas reserves, capital exposure and various economic yardsticks. Monte Carlo is a part of risk analysis and an integral part of portfolio management and can also be used in conjunction with decision tree analysis. Risk analysis is any form of analysis that studies and attempts to quantify the risk associated with an investment. The concept of risk analysis allows the analyst the option of describing risk and uncertainty in the form of distributions of possible values attributable to uncertain upstream oil and gas parameters such as porosity, drilling costs and pay thickness. These distributions are then combined to yield a distribution of possible levels of profitability to be expected from the project. From this distribution it is possible to determine an overall expected value parameter which can be used in the decision making process. It should be noted that Monte Carlo simulation does not make decisions, but merely assists management in decision making.

Expected Monetary Value & Decision Tree Analysis

The fact that investment decisions are made under conditions of uncertainty, necessitates the need for a risk weighted average profit (or other measure of value) to be incorporated into the decision process, via decision analysis. This in turn enables risk in investment decisions to be expressed as a quantitative measure.
The concept of expected monetary value (EMV) is simply a means of combining profitability and estimates of risk (via numerical probabilities) to yield a risk adjusted value. The EMV decision rule states that, all factors being equal, when choosing among several mutually exclusive options the decision-maker should select the option with the highest positive EMV. The EMV of an outcome is the result of multiplying the probability of occurrence of the outcome and the conditional value that is received if the outcome occurs. Since by definition each decision alternative will have at least two possible outcomes, the EMV of a decision alternative is merely the algebraic sum of the EMV of each possible outcome that could occur if the decision alternative is accepted. The EMV of a decision alternative can be positive, zero or negative. It is this numerical criterion that is used to compare competing decision choices. A typical example of such a choice in the petroleum industry could be whether to drill a wildcat well based on existing information or whether to acquire additional information via seismic surveys before proceeding to drill.

Although the process of evaluating the risk weighted monetary worth of petroleum acreage can sometimes involve a single decision, in most cases the initial decision to drill is merely a link in a chain of future decision options. Decision tree analysis is a means by which the decision-maker can identify the optimum decision path available and evaluate the maximum expected NPV.

Real Options Approach

It is well known that companies typically pay more for an asset than the base cash flow results would indicate. These premiums are often paid to account for the perceived value of managerial flexibility.
A recent study carried out by Andersen analysed fifty historical North Sea oil & gas investment transactions. The aim of the study was to determine whether the premiums paid for these assets could be justified. The results of the study showed that on average a premium of 10% was paid to acquire assets. Further analysis, based on current knowledge of the assets showed that the market had in fact paid a 29% premium to acquire the assets in question. In all it was found that 75% of the assets had not justified the premiums paid and that investors consistently paid too much to acquire assets. The results of the study thus highlight that the market is unable to accurately assign arbitrary premiums to account for managerial flexibility, and emphasise the need to identify methods to appropriately quantify the flexibility component of value.
Real Options analysis is a relatively new asset valuation technique gaining widespread acceptance for its ability to help quantify the value of managerial flexibility. As uncertainty surrounding market conditions and future cash flow is gradually resolved,

management may have valuable flexibility to alter its initial operating strategy so as to optimise future return on investment.
In the same way that managerial flexibility equates to financial options, a real options approach to investment appraisal is based on financial option theory. Whereas financial options apply to a security such as a share or bond, Real Options apply to a tangible asset, for example a business or a project.

Embedded in any oil & gas field development is a series of real options open to management. Through real options we can effectively determine the value of these options. Real Options that apply to upstream investments, include:

- Deferral option (the right to delay exploration, development, incremental investment)– American call option
- Option to abandon (the right to abandon the field early) – American put option
- Option to contract (selling a fraction of the project for a given price) - American put option
- Option to expand (the right to invest in additional compression) – American call option
- Option to extend (the right to defer abandonment due to favourable economic conditions) – American call option

The value of flexibility is always positive, however the price to be paid often exceeds its value.

The following formula applies for the Real Options approach:

Expanded NPV = Passive NPV (traditional approach) + Value of Flexibility (option value)

With regards to the application of option pricing theory to investment appraisal there are generally two different types of models.

Black and Scholes (discrete time model)

Binomial model (continuous time model)

The Andersen approach to real options in upstream oil and gas adopts the binomial model, which uses a stochastic process (Geometric Brownian Motion), to account for the uncertainty in future oil price. This model is selected because it is more intuitive and conceptually closer to decision tree analyses than the Black and Scholes method.

One of the fundamental concepts underlying the subject of real options is a risk neutral valuation approach in which future cash flows are discounted at the risk free rate of

return. The use of risk free valuation negates the need for the selection of a risk-weighted discount rate. Economic risk (oil price) is accounted for through the use of oil price volatility and risk neutral probabilities. Technical risk (reserves, pay thickness etc) is accounted for through the use of Monte Carlo simulation once the relevant technical uncertainties are identified. Figure 1 below summarises Andersen's approach to real options valuation.

Figure 1:Andersen's Approach to Real Options in Upstream Oil and Gas
We use a step process to valuation approach:

1. Calculate base case NPV without flexibility	➢ Data collection for the base case, including production, capital costs, operating costs, tariff payments/receipts etc. ➢ Determine a base case oil and gas price view. ➢ Using the Financial Analysis Service (FAS) model the asset, using the base case data, to obtain an NPV without flexibility. Discount using the weighted average cost of capital.
2. Quantification of technical risk using Monte Carlo simulation and Stochastic modelling of product prices	➢ Conduct a risk and options identification workshop. Where possible a multi-disciplinary team should be present. ➢ Use Monte Carlo simulation to quantify the uncertainty surrounding each input variable. ➢ Use Geometric Brownian Motion (GBM) to model product prices.
3. Construct a decision tree which incorporates managerial flexibility	➢ Construct multiplicative binomial models. ➢ Incorporate managerial flexibility into the decision nodes.
4. Conduct the Real Option analysis to produce NPV's which incorporate managerial flexibility	➢ Use the Risk Neutral Valuation approach to adjust event probabilities and apply the use of the risk free rate when discounting. ➢ Expanded NPV calculated by combining Monte Carlo simulation, the FAS, GBM modelling and the multiplicative binomial models.

Real Options analysis carried out by Andersen in oil and gas indicate that the value of managerial flexibility can add as much as 45% to the base case NPV. The ability of real options to help quantify the value of managerial flexibility is a significant advancement in valuation techniques and can help improve investment decisions and facilitate the creation of shareholder value. It is expected that as the petroleum industry moves increasingly towards marginal field development, the use of this technique will eventually become state of the art.

Portfolio Management

A portfolio is an aggregation of investments. Portfolio managers mix their investments to reduce collective risk and enhance return on capital employed. Optimisation is often taken as maximising some measure of profitability, such as traditional/expanded NPV or expected monetary value (EMV), subject to constraints on risk, usually through the application of modern portfolio theory.
It is generally well understood that by holding risky assets in groups, some of the risk of each asset may be reduced or eliminated through the process of diversification. It should be noted however, that only risk that is unique to a particular asset (non-systematic risk) can be reduced or eliminated through diversification. Risk that is shared among all assets (systematic risk) is non-diversifiable. This is because it arises from the correlation between the asset returns and the market returns driven by economy-wide forces affecting all assets in the market (e.g. budget deficit or inflation), which therefore cannot be diversified away. The total risk of an asset is therefore given as:

Total risk = Systematic risk + Unique/Non-Systematic risk

The subject of portfolio theory was developed in the 1950's as a method for analysing and managing portfolios of marketable securities. Portfolio theory can be used to quantify the risk and expected return of portfolios of oil and gas producing assets as well to identify potential acquisitions that can optimise the firms risk return relationship and create value through active portfolio management.

Portfolio management can be described as a two step process which

A) Determines the expected return and variance of return for all possible combinations of the available investments, including the effects of diversification via Monte Carlo simulation.
B) Selects from all possible portfolios the efficient portfolios, which for any given level of risk exhibit a maximum return. This set of efficient portfolios is referred to as the efficient frontier.

Through the process of carrying out a risk analysis and the investigation into the effects of diversification and exploitation of project synergies it is possible to determine those assets which will provide an optimum portfolio. Through active portfolio management an organisation can identify both investment and divestment opportunities which can help develop the optimum aggregation of assets so as to maximise the firms return on investment and maximise shareholder value. It should also be noted that through portfolio management a firm is able to identify opportunities not only to maximise return on investment but also to identify opportunities for the firm to reduce its exposure to risk.

As full cycle economics of oil producing regions becomes increasingly marginal, active portfolio management is set to become crucial if firms are to identify suitable acquisition opportunities and optimise the risk-return relationship. Failure to adopt active portfolio management could lead to firms losing their competitive edge in a volatile market and being exposed to unnecessarily high levels of risk.