PORTFOLIO OPTIMIZATION APPLIED TO ACQUISITION EVALUATION[1]

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ABSTRACT

The paper describes some of the lessons learnt in building a portfolio model of petroleum assets. The example is based on the evaluation of an acquisition opportunity, a setting which imposed it's own constraints on the methodology. The discussion focuses on how we reduced the problem to manageable proportions by categorizing and ranking the unknowns. It contrasts asset and portfolio performance, illustrates some practical aspects of asset model design and input description. Finally, it describes the use of OptQuest® to optimize the portfolio under selected scenarios.

1 INTRODUCTION

This paper describes an approach taken to evaluate the behavior of a portfolio of assets to a variety of scenarios, constraints, decisions and uncertainties. The example was an acquisition opportunity. The aim was to provide the negotiating team with sufficient information to establish a purchase price and shape a deal that mitigated the inherent risks and preserved the opportunities.

This type of problem is commonplace, and most readers will have experienced just such a challenge. To tackle the myriad of combinations, we needed an effective process and efficient tools to reach a supportable decision in a reasonable time-frame. To preserve confidentiality, we will describe the generic method but hopefully in a manner that readers can relate to and apply to their own situations.

The opportunity encompassed many assets including producing fields, undeveloped discoveries, and exploration prospects. The reservoirs comprised a variety of formations, fluid types and drive mechanisms. We had a reasonable, but perhaps not an exhaustive, understanding of each asset.

At first, the task of providing a timely and confident analysis appeared overwhelming. However, although the performance of each asset was uncertain, they behaved, to a large extent, independently. Thus the risks in one would tend to offset the opportunities in another. Since our aim was to evaluate the portfolio as a whole, we could be more comfortable accepting a higher level approach to the individual asset evaluations. This greatly simplified the analysis.

2 BASIC DETERMINISTIC APPROACH

A basic approach to evaluate the portfolio would be to compile mid-range values of each parameter from our discipline specialists and build single point deterministic estimates of the performance of each asset. To build a development portfolio, we would then rank and schedule the assets to conform to a scenario. For instance, if we sought to maximize net present value (NPV) under a capital constrained scenario then we would rank the projects as a function of investment (NPV/I) and schedule developments in rank order while keeping expenditure within the defined limit.

This approach has the advantage of quickly providing valuable insights into the problem. It is also simple and conventional, which makes the task of explaining the results quite straightforward.

3 BROADER DETERMINISTIC APPROACH

If we seek a more thorough investigation, we have a choice to focus on depth or breadth. In the former, we may perform more detailed work to justify the selection of the mid range values. However, our time may be better spent broadening our outlook under the belief, to paraphrase the words of John Maynard Keynes, that it is better to be vaguely right than precisely wrong.

The first stage of a broader approach would be to ask our discipline specialists for low and high values of each unknown and repeat the exercise to provide a range of values of each asset and the enterprise as a whole. This adds another dimension to our understanding and begins to indicate how badly we could be wrong and how much upside potential there may be.

It also raises some questions such as: "How low is the low estimate for each parameter?" or "How should we combine the values of each parameter to determine a high value of the enterprise as a whole?" and taking our previous example, "Which value of NPV/I should we use to rank and schedule the assets and build the portfolio?"

4 STOCHASTIC APPROACH

To address these questions, we first need to attach probabilities to the estimates. As a first pass, this can be done qualitatively and quite quickly by extracting a little more information from our discipline specialists. We could ask: "Is this the lowest value you can conceive?" or "What are the chances of exceeding your high estimate?" and "Does this distribution represent your expectations?" It often helps a specialist who has, for example, a conservative bias, to release an upside estimate provided it is attached to a low probability of occurrence. We can now at least perform the correct calculations to estimate the range of expectations for each asset. Depending upon the correlation between parameters, this may yield significantly different results from the earlier three point analysis.

To schedule the assets and construct the optimum portfolio for a particular scenario, we moved from a one dimensional ranking procedure to an optimization process. The first step in the process was to identify and categorize the most important parameters which impacted the value of the enterprise. The two most sensitive parameters were product price and commercial terms, which rose to the top because they acted on all the assets and because each possessed a wide range of expectations. We categorized product price as an uncertainty and the commercial terms under negotiation as a decision, but let us postpone further discussion of these parameters until after we have described how we optimized the portfolio of assets.

Turning to the individual assets, the most sensitive parameters were rate, project delay, recovery factor, volume in place, and capital expenditure (capex). We categorized rate and delay as decisions, while recovery factor, volume in place and capex were uncertainties under which the decisions were taken. We used fixed values for most of the remaining and less sensitive parameters. The rate decision defined the design rate and was correlated to capex, although we retained uncertainty in the cost estimate at a given design rate. Recovery factor and volume place determined how long the asset remained at design rate plateau.

The fact that all the asset parameters were subordinate to price and terms provided a driver to adopt a high-level approach to individual asset evaluation. Furthermore since the two most sensitive asset parameters determined when and how the projects would be scheduled, it was logical to look harder at portfolio optimization. We used Crystal Ball® from Decisioneering®, Inc., to handle the stochastic analysis and provide a means to identify the most sensitive parameters. We used the embedded program OptQuest from OptTek Systems Inc. to optimize the decisions under various scenarios.

Returning to the capital constrained example described earlier, we specified a capital constraint by year. This added the practical consideration of "do-ability", that is, how many capital projects we could execute simultaneously, both at the outset and in future years. We defined the target for the optimization as the maximum mean NPV. The optimizer found the combination of rate and delay decisions for each asset which maximized the mean NPV within the defined constraints. An example of what this would look like if shown in Figure 1.

A build on this was to consider gas supply scenarios which we represented by adding constraints to the gas rate profiles to meet domestic and export requirements. Again, we used the optimizer to find the optimum combination of rate and delay decisions for each asset while honoring the production and capital constraints dictated by the scenario.

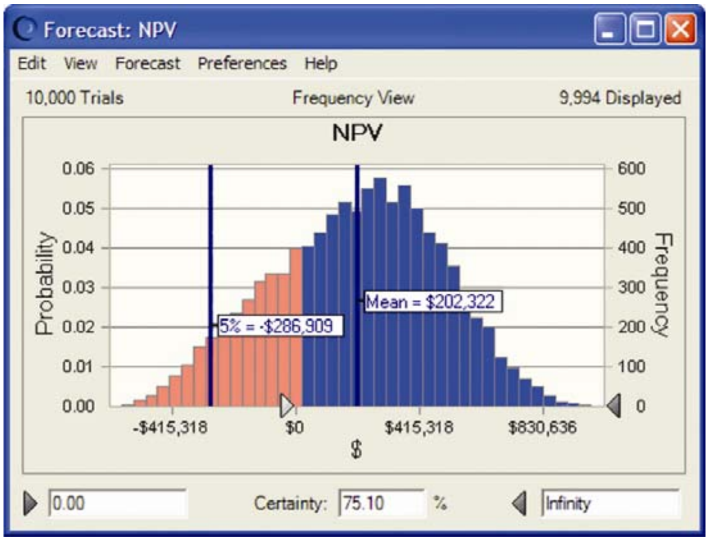

Figure 1: Stochastic Net Present Value

5 STOCHASTIC OPTIMIZATION

The optimization was performed on the stochastic problem so the uncertainty was preserved. For each scenario, we had a distribution of the NPV target parameter and any other output variable, such as the distribution of production profile over time. This allowed us to appreciate the risk and uncertainty in the prediction. If either one gave grounds for concern, we could further build the scenario to specify risk or uncertainty constraints.

By risk, we mean the chance of an undesirable outcome. We evaluate the impact of imposing risk tolerance limits by specifying additional constraints on risk measures such as payback time, maximum negative cash flow or minimum low-side (P10) NPV. By uncertainty, we mean the range of outcomes, and we evaluate this by specifying a maximum standard deviation of NPV.

The ability to optimize a portfolio efficiently freed us to evaluate "what-if" questions at a portfolio level rather than an asset level. It was a means to gain insights that would have consumed too much time to generate manually. However, it was important to probe the impartial solutions in order to mine insights. The better we understood how and why the enterprise behaved, the better equipped we were to make decisions. Sometimes the solutions were intuitive and matched a rank order, sometimes not. Sometimes the enterprise value was sensitive to a scenario, sometimes not. Ultimately, the problem could be described by a half dozen key scenarios which the negotiating team could use to help decide, "How can we structure the deal to give us the least exposure, and highest likelihood of success, or highest profitability?"

Finally, let us return to pricing and terms. Pricing is both a commercially sensitive issue and a sensitive parameter in the evaluation. Many companies are particular about how it is handled. Suffice it to say that to include a stochastic price forecast within the optimization, we must specify the bounding range of expectations over time and also the rules which govern how the price can change from one year to the next. In the absence of this definition, the alternative is to evaluate the sensitivity of the optimized scenarios to deterministic price forecasts.

As far as terms go, we could conceivably have represented alternative structures as decisions within the optimization. This could yield, for example, the optimum combination of payments up-front, over time or by asset performance. However, even without this step, we had an interesting task to explain the methodology so we elected to explore this option at a future opportunity.

BIOGRAPHY

Chris Hill is a Development Manager with Marathon Oil in Houston, where he currently evaluates business development opportunities. He has been with Marathon for 20 years in various engineering capacities in Aberdeen and Lafayette before moving to Houston in 2000. Prior to Marathon, he worked for Schlumberger in the Middle East and a British independent company called Burmah Oil. Chris holds a B.Eng degree from the University of Liverpool and an MSc in Petroleum Engineering from Imperial College, London.