

Efficient Portfolio Selection

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If portfolios made up of a selection of petroleum projects are plotted on a graph of expected value versus risk, there is an upper boundary above which no portfolios are found. This upper boundary is known as the efficient frontier.

Harry Markowitz revolutionized the field of portfolio theory with his pioneering work in the 1950s (1, 2). His approach to efficient frontier analysis uses matrix algebra to determine an analytical expression for the line representing the efficient frontier.

In applying efficient frontier theory to the realm of the petroleum industry, Merak has taken a different approach. Merak's approach uses previously generated Monte Carlo results and a random portfolio generation scheme to plot thousands of valid portfolios on an efficient frontier graph. It quickly becomes apparent that there is an upper boundary, although a line is not explicitly drawn.

Both of these approaches have strengths and weaknesses. For instance, Merak's approach lacks the analytical certainty regarding the efficiency of promising portfolios that the Markowitz approach has. Even though there may seem to be no portfolios above a particular portfolio on the graph, it is always possible that the next randomly generated portfolio will be the best yet.

On the other hand, the Markowitz approach has some severe limitations when applied to the petroleum industry:

- The simplification of describing a risk profile with only a mean and variance will lead to inaccuracies in the efficient frontier.
- It may not be possible to participate in a project at an arbitrarily fine level of granularity. Some projects may be such that they require 100
- The constraints that determine which portfolios are valid can be complicated in the petroleum industry. Constraints like "If A then also B, C, and D" or "If E then not F or G" or "At least 2 of H, I, J, and K" cannot be easily expressed as a linear equation, which is required for the Markowitz approach.

The goal of this project is to address the weaknesses of the two approaches, potentially by combining or partially combining them. A efficient frontier analysis method that combined the robustness of the Monte Carlo approach with the confidence of the Markowitz approach would be a powerful tool for any industry.

1. Harry Markowitz, "Portfolio Selection", The Journal of Finance, Vol. VII, No. 1, March 1952, pp. 77-91.
2. Harry Markowitz, "Portfolio Selection: Efficient Diversification of Investments", Blackwell Publishers, Cambridge MA and Oxford UK, second ed., 1997. (originally published 1959)