Predicting Economic Value in Unexplored Regions of an Unconventional Liquids Rich Play

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Summary

A requirement for appraisal of unconventional resource plays is the development of type wells: predictions of production results for future wells drilled in a geologic subset (areas with relatively homogeneous reservoir properties). Unfortunately, evaluators typically have a limited sample of wells available, so while the subset may be relatively homogeneous, the full range of reservoir properties may not have been sampled. Unconventional plays also have gradational changes in reservoir properties, so defining a "homogeneous" geologic subset disregards these gradients. This paper presents a workflow to deal with these issues.

In this workflow, type wells are modified to account for the expected difference between a sampled region and an unexplored region of a given geologic subset. Since well productivity and key inputs (e.g. completion design, reservoir quality) are not perfectly correlated, statistical relationships are used to modify type wells while accounting for uncertainty. Combined with an economic model and the expected variability in reservoir properties, a regional map of break-even oil price is generated. This map highlights potential "sweet spots" by incorporating the gradational trends of multiple reservoir properties and can be used to discuss a multitude of appraisal and development issues.

Theory

In this paper, the Duvernay formation in Alberta, Canada is used to illustrate this workflow:

1) Construct type curve ranges for origin geologic subset;
2) Correlate empirical relationships between productivity and key input variables;
3) Normalize and cluster data into equal sample size bins, correlating common percentiles between each bin (P10, Mean, P90);
4) Construct probability distribution of range of slopes from percentile correlation;
5) Use Monte-Carlo simulation to sample this distribution and origin subset type curve distribution;
6) Construct new distribution from product values of each simulation run;
7) Repeat for several points across full range of subsurface variable values;
8) Run economic model at each point to capture key metric (e.g. breakeven oil price);
9) Construct multi-variable regression model to correlate economic metric with subsurface inputs;
10) Map key economic metric across regional fairway.

Results, Observations, Conclusions

By applying this workflow, productivity of an unconventional play can be predicted where key inputs have changed. This allows heterogeneity across unconventional fairways to be accounted for and empirical variability to be captured rather than simply averaged. Application of this workflow allows for stochastic "step-out" predictions to be made for unexplored regions of an unconventional fairway.

Novel/Additive Information

This paper offers a novel approach to characterize empirical relationships between subsurface or completions variables and productivity. Using a statistical model, empirical variability can be built into predictions of key production metrics given variable reservoir quality. This represents a tangible improvement over common deterministic techniques. By combining this technique with both economic and subsurface models, a regional map of economic value across an unconventional fairway is constructed.