

How to Value Proved but Undeveloped Petroleum Reserves

Lawrence M. Vielhaber^a

Proved undeveloped reserves (PUDs) are typically assigned a value of zero when the cost to produce them is greater than the prevailing forward curve. A key reason for the zero valuation is the inability to model future hedging opportunities, without which financing is untenable. To accurately value PUDs, one should model them under the financial assumptions that exist when production of those PUDs occurs. Since that production will, in virtually all cases, involve hedging, modeling the PUDs should also involve hedging. Choosing some deterministic price forecast, such as the current forward curve, as a basis for a hedge is of little use because (a) that forward curve is unlikely to exist when production starts and (b) banks cannot count on a contingent hedge as a basis for collateral. Thus, PUDs are typically valued at zero when in fact the positive option value they possess is intuitively obvious.

The model presented in this paper attempts to demonstrate advances in the state of modeling PUDs by introducing a methodology for estimating stochastic future forward curves. The model generates these future forward curves so that, in each simulation, we model not expected hedging, but hedging as it ultimately plays out, scenario by scenario. Opportunities for leverage can then be modeled because in each state of the world the specific hedge is known.

The research consists of a two-pronged modeling approach that first estimates past crude oil and natural gas forward curve behavior and then applies that behavior to what could happen to oil and gas prices in the future. We project not just future spot prices, but with each future spot price there is attached to it a forward curve that represents a price path that is hedgeable. The model is simulated thousands of times, providing a rich tapestry of future states of the world, all fully consistent with past forward curve behavior while centering on current price projections.

PUD valuation, complete with financing capabilities, becomes possible since future hedging is based on future forward curves as they exist at the time the PUDs are drilled and financed. The research shows that a large swath of subeconomic PUDs, currently valued at zero, have positive expected value when financing becomes part of the equation. It sheds light on the economic viability of the underlying physical optionality, currently unrecognized, embedded in oil and gas underground.

^a Adjunct Professor, Graduate School of Business, Ohio Dominican University, 5139 Old Field Court, Westerville, Ohio 43082. E-mail: Larryvie1125@gmail.com