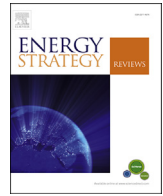




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Re-appraisal of the Bakken Shale play: Accounting for historic and future oil prices and applying fiscal rates of North Dakota, Montana and Saskatchewan



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ABSTRACT

The ascent of the Bakken shale play as a major U.S. oil producer became threatened by the 2014–2016 oil price fall. This benchmark study assesses and compares the economic performance of typical Bakken wells across three different fiscal regimes: North Dakota (ND) and Montana (MT) in the U.S., and the Canadian province of Saskatchewan (SK). Decline curve analysis and discounted cash flow analysis are applied to evaluate and re-appraise both the productivity and economic performance (internal rate of return, IRR) of typical Bakken wells in each region. For wells of similar estimated ultimate recovery (EUR), the fiscal regime of Montana (IRR 27%) is slightly more advantageous than North Dakota's (IRR 24%). If wells can be identified in SK akin to ND's reference well of 555 Mbbls EUR, the Canadian province provides the most attractive after tax return (180%). However, type curves for Bakken wells in SK and MT analyzed in our study typically have EURs at only 14% and 37% of the ND reference well (EUR=555 Mbbls) and IRRs adjusted for EUR in MT and SK are negative in both regions at the historic reference price of \$80/bbl. A sensitivity analysis using oil prices ranging between \$20–100/bbl accounts for any of the price levels seen in the 2014–2016 price fall, and can be projected forward. The evaluation of single well economics and sensitivity to oil price changes and drilling and completion cost is subsequently expanded with a representative firm approach considering certain asset development options with multiple wells in each of the three Bakken jurisdictions (ND, MT, SK).

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1. Introduction

1.1. Rationale for our study

Shale plays need to be assessed economically in order to better understand their viability for further sustained development as a vital part of the global energy system. Our study provides a detailed example of such an assessment through economic life-cycle analysis of the oil production in the Bakken shale play which stretches across North Dakota, Montana and Saskatchewan. Forward price scenarios and efficiency gains are taken into account and reveal what may make future operations in the Bakken shale play either profitable or unprofitable. The study provides a template for the assessment of similar shale plays elsewhere. Additionally, our study

may aid companies in formulating tactical responses at corporate level to mitigate the adverse effects of declining oil prices (of fall 2014 thru 2016).

Unconventional oil producers in North America need to adapt their business plans to mitigate the impact of oil and gas price volatility, which recently included epochs with depressed natural gas prices (2009 thru 2016) and steep declines in oil prices (2008–2009 and 2014–2016). The present study assesses the impact of the latest oil price plunge on the economic performance of typical wells in the Bakken play, which has emerged as the world's 2nd biggest shale oil producer, after the Eagle Ford (Fig. 1; see Section 2.1 for details). The performance of typical Bakken wells is economically benchmarked under three different fiscal regimes: North Dakota and Montana in the U.S., and the Canadian province of Saskatchewan. We first evaluate regional type curves for each state/province and then select a representative type curve to compare the impact of the different royalties and taxes due in each

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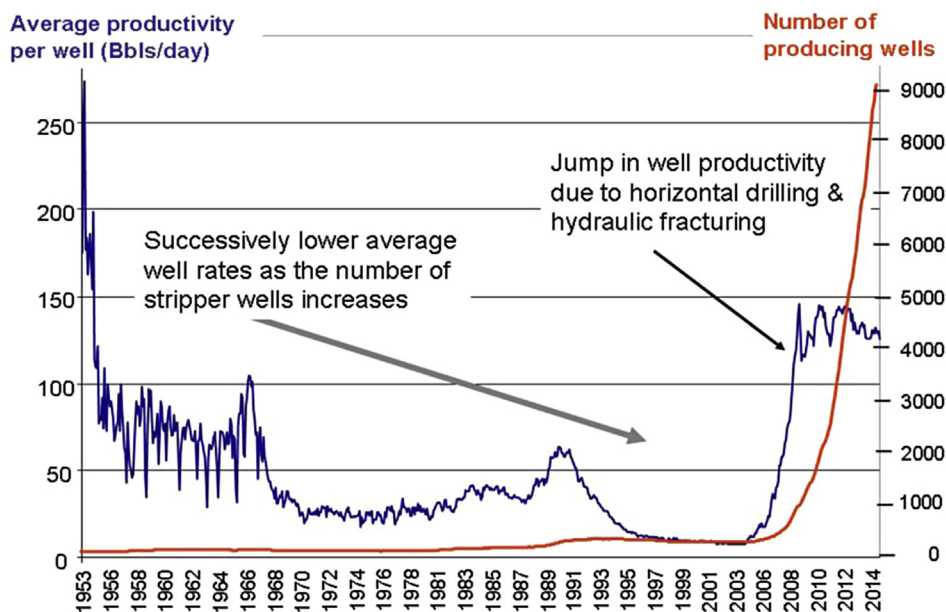


Fig. 1. Historic average well productivity (left hand scale) since the first well was spud in the Bakken in 1953. We attribute the overall decline in well rates over the period 1953–2006 to an increasing number of stripper wells over time. The decline in average well rates was abruptly reversed by the advent of horizontal wells and hydraulic fracturing, beginning in 2006 (right hand scale). The number of producing wells jumped several orders of magnitude since 2006. Plotted from primary well data of North Dakota Industrial Commission, Department of Mineral Resources [14].

jurisdiction, for a range of oil prices.

Whether profitable development of any Bakken assets is still feasible with depressed oil price scenarios is part of our assessment. The after-tax internal rate of return (IRR), net present value (NPV) and revenue sharing *between operators and government* are specified for Bakken wells in North Dakota, Montana, and Saskatchewan. By first analyzing a *representative property* (using North Dakota type curves) we calculate the fiscal take versus operator take, applying the specific taxes and deductions for the fiscal regime of each state/province.

In addition to the representative property approach that analyzes the typical well performance in each state, our analysis proceeds to assess the performance of a *representative firm* operating typical wells across the three fiscal regimes. De-risked acreage must accumulate fast enough to build shareholder value through organic asset growth and/or profitable acquisitions (in lieu of dividends). Our study helps to answer the question what commodity prices and technology cost savings will keep open the door for sustained development of the significant hydrocarbon resources in the Bakken Shale play. Our main conclusion is that only the very best portions of the play in Montana and North Dakota are economic at sub \$50/bbl oil prices, which explains the reported 80% reduction in rig count in the region over the period 2014–2016. The region needs \$65/bbl oil prices to broadly return to normalized, profitable development. The threshold price can be lowered further through innovation and efficiency (see Sections 5.2 and 5.5).

1.2. Perspective of our study

Our study aims to be useful for a variety of stakeholders. The present study does not consider societal resistance that may prevent the development of shale resources in certain parts of the world (e.g. see Ref. [42]). In the Bakken region, there is commonly broad support for hydrocarbon extraction activities as it has been such a vital part of the regional economy and job provider. Our analysis may be useful to public sector planners, revenue forecasters and service providers who need to know how Bakken

investors will respond to different oil prices. The study may also serve as a template for the development of shale resources elsewhere in the world. Many stakeholders have poor access to proprietary cost and production information.

We assess the competitiveness of oil and gas production for three sub-regions in the Bakken Shale, including a transnational examination based on fiscal regimes with differences in royalties and state/provincial and national taxes. The model developed by us for comparative economic performance (NPV, IRR) accounts for regional variations in geological attributes, type curves, royalties and taxes. By including an in-depth analysis of the various fiscal regimes (Appendices A–C), we aim to provide an accurate picture of “real world” economics in the Bakken play. We include different commodity price scenarios, which evidently is one of the most critical parameters required for establishing resource development thresholds.

Our analysis covers the full life-cycle of the wells and accounts for upfront capital costs with capitalization based on an even split of debt and equity. The retained earnings model of a hypothetical company is analyzed in detail accounting for all expenses and actual revenue streams based on a drilling program and large range of price scenarios until the resource in the company acreage is depleted. Finally, we compare our model retained earnings with the actual performance of various publicly held companies to extend the analysis beyond the theoretical modeling to encompass real world experience.

2. Bakken play characteristics and type curves

2.1. Production history

The emergence of the Bakken as a major oil play is a relatively recent development (<10 years) in an oil field that languished for several decades after the first well was drilled in 1953. Oil production data compiled for the Bakken in North Dakota divided by the number of active wells gives an average production rate for individual wells of 175 bbls/day for 1953 (Fig. 1; left hand scale).

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