Overview

In 2008, the U.S. Geological Survey conducted the first large-scale geology-based assessment of the Williston Basin of North Dakota, Montana, and South Dakota. Although it had long been known that large quantities of unconventional oil and gas resources were present in the basin, the assessment estimated the total amounts in various discretely defined areas within. Given the high costs of private exploration typically needed to locate optimal subsurface geology, I treat the results of the assessment as an exogenous shock of free information and study how upstream oil and gas firms exploited the results as a strategic aid to narrow their search and acquire more economically preferable leased acreage, among other development outcomes. Post announcement of the survey results, in areas of the basin where “more” hydrocarbon resources were estimated I show economically significant changes in the number of lease acquisitions, the average lease size and, importantly, changes in the terms on new leases, relative to the same outcomes in areas of the basin where no assessments were conducted. These findings are important because they provide insight about how government-funded projects are used in industry, which is sought by the U.S. Geological Survey to determine the value of its work. Further, asymmetric information is important in this context because firms who internalized the assessment results quickly were plausibly able to exploit an arbitrage opportunity that enabled the negotiation of more favorable terms on lease agreements. Hence, at the expense of mineral right owners, fast-acting firms were likely able to lock in lower royalty rates that entitled them to a larger share of production before the leasing market adjusted to reflect the higher true value of leases in more resource abundant areas.

Methods

This paper examines the extent that the results of a USGS resource assessment published in April 2008 caused changes in oil and gas leasing activity—namely, the geographic location and the negotiated terms on new leases—in the Williston Basin. As indicated by Smith (2018), prior to 2009, the development of the basin was still very much in its infancy as few wells had been drilled and firms were not well able to distinguish high potential from low potential drilling sites. Instead, a conglomerate of small and medium-sized (at the time) independent firms in the region was primarily focused on transitioning drilling and completion inputs and techniques used in unconventional shale gas plays to those containing shale oil. Given the expansive 300,000-square-mile extent of the basin, the publicly available results provided a plausibly exogenous shock of information on the distribution of geology and resource abundance, which I hypothesize firms used to narrow their search radius and fine-tune their beliefs on the potential “sweet spots.”

Exploiting the results as a natural experiment, I treat the six assessed areas and the lone unassessed area within the basin as my spatial units of observation. I then create monthly values for a set of leasing activity outcomes in each area. The primary outcomes of interest are a count for the number of new lease acquisitions, the average size of a new lease, and the average royalty rate bonus payment, and primary term length, and others. These outcomes were chosen as they enable me to study strategic positioning by firms on the landscape, and are the most commonly negotiated lease terms and those that economic theory would predict to constitute profit-maximizing firms strategies used during lease acquisition. Since upstream firms are commonly valued based on the quality of their acreage, an intuitive development strategy would include amassing contiguous acreage over better geology, and negotiating longer primary terms or the option to extend the primary term, and lower royalty rates and bonus payments in order to maximize the expected value of leases.

To analyze the effects of the assessment on leasing activity within the Williston Basin, I implement a difference-in-differences methodology. My estimating equation is as follows:

\[ Y_{it} = \beta_0 + \sum_{k=1}^{K} \delta_k \text{Post}_t \times AU_{it} + \beta X_{kt} + \lambda_t + \gamma_i + \epsilon_{it}, \]

1 McFarland (2014) and the online appendix of Vissing (2018) describe in detail the basic or “essential” lease terms that should be considered by a mineral rights owner in order to negotiate a reasonable and fair lease, and many other clauses, or addendums that appear on leases and have important implications for profitability. It is apparent that there is a positive correlation between the occurrence of these clauses (i.e. more lessor-favorable lease agreements), bargaining experience, and lessors that that do their due diligence before signing a lease or consult with an attorney prior to agreeing to terms, as recommended by McFarland (2014).

2 Upstream oil and gas firms are commonly valued based on their primary assets—proven oil and gas reserves (Gold 2014, pp. 129), which are hydrocarbon deposits that can be extracted under current prices and existing technologies. Reserves are different from resources, defined as all hydrocarbons that can technically be recovered at any price. These terms are commonly misinterpreted, and in this paper, I assume that the amount of resources in an area has a close correlation with the amount of reserves, or at least provides a signal of resource abundance to firms.
where \( Y_{it} \) is one of the value for development outcome \( k \) of area \( i \) in month \( t \), and \( Post_{t} \times 2008AU_{i} \) is an interaction term between an indicator for the time the assessment results were announced (April 2008) and an indicator for assessment unit \( i \) (\( AU_{i} \)). The parameters on the interaction terms are of primary interest, and estimate how development outcome \( k \) in \( AU_{i} \) changed relative to the unassessed area. I also include a set of controls for each area, \( X_{kt} \), and year-month and area fixed effects, \( \lambda_{k} \) and \( \gamma_{k} \), to control for time trends common to all areas (e.g. oil price) and trends that are specific to each area (e.g. average differences in leasing activity, local geology, and other area-specific differences), respectively. Post assessment, I predict leasing activity to increase in AUs estimated to contain more oil and gas, as geology and resource availability became more certain, with the largest increases in activity occurring in the areas estimated to contain the most oil and gas. The identifying assumption is that absent the assessment, leasing activity outcomes in the assessed area would have trended similarly to the activity in unassessed areas.

Results

The results in this paper provide intuition about where changes in leasing activity occurred in the Williston Basin after the assessment, and insight on how firms in the region internalized the results. I find that the assessment had a statistically significant effect on the number of new leases acquired in all areas, yet the effects were negative for three of the assessed area, particularly the two areas estimated to have the fewest and the most estimated resources. The result for the latter is intuitive when combined with other findings that show a highly significant and large increase in the average size of a new lease post assessment in this area. When taken together, it means that fewer leases were acquired, but the leases that were acquired were significantly larger than the leases acquired elsewhere, indicating that lots of unleased acreage existed in this area prior to the results of the assessment, which changed quickly after the results were announced. I also find significant and economically meaningful effects on the terms of negotiated leases, including changes to the average primary term, average royalty rate and bonus payment, and compositions of leases with options to extend the lease upon expiration of the primary term. Although the findings vary across areas within the basin, the terms in some areas exhibit pass-through to of geological quality into royalty rates and bonus payments (to the benefit of mineral rights owners), but in other areas the assessment proved more favourable to the industry, echoing that asymmetric information likely existed during leases negotiations in the early development of the basin.

Conclusions

An increasingly large literature in economics has studied how information contributes to oil and gas development. Regarding exploration and production, previous research has concentrated on how information is acquired with experience and is used to inform future drilling location and input decisions (e.g. Kellogg 2011, Covert 2015, and Agerton 2019). USGS assessments of oil and gas resources are an important source of information and are highly relevant to energy policy, especially as recovery-enhancing techniques such as horizontal drilling and hydraulic fracturing have become widespread in the U.S. and increased the potential exposure for a variety of spillovers from oil and gas activities by expanding the area of development. These technologies, combined with better information supplied by the assessments likely enable more efficient wells to be drilled that have less production uncertainty. The results of this paper indicate that during the early stages of the development of a new play; firms may have less knowledge on geology than previously believed, and they seek external sources of information that helps them to strategically shift and narrow the radius of their search for favorable geology. This is intuitive for at least two reasons. First, the acquisition of accurate geologic knowledge and information is time intensive and costly, and there had been minimal exploration occurring in the basin prior to the boom—meaning, there was relatively little information available to base location decisions on without spending on exploration. Second, the key driver of the boom in this region was a collection of many small, independent firms who had less sophistication and fewer resources than many of the larger firms who entered late and essentially needed to use all external information available.

References


