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Information spillovers in onshore oil and gas exploration *

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ARTICLE INFO

Article history: Received 17 June 2014 Received in revised form 18 April 2016 Accepted 18 May 2016 Available online 2 June 2016

Keywords: Exploration Oil Natural gas Information

ABSTRACT

I investigate information externalities in onshore oil and gas exploration using data from Alberta, Canada. I use information in the drilling histories of firms exploring Alberta for oil and gas to estimate various models of exploration rates. The objective is to study how the outcomes of previous exploration decisions, under both private-information and public-information assumptions, as well as timing, influence firms' exploration rates across Alberta. The results show that firms' exploration rates were influenced by both its own drilling history as well as by the outcomes of other firms. The drilling histories of other firms had important effects on a firm's decision to explore a region if the firm had yet to start exploring that region. However, once a firm had started to explore a region, the outcomes of rivals were less important than the firm's own outcomes. Additional results provide an interesting characterization of the different factors that affect firms' exploration decisions.

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1. Introduction

This paper is an empirical analysis of the role of information in the decisions of firms exploring for oil and gas. Oil and gas exploration provides an interesting opportunity to study information in investment decisions. The distinguishing features of investment in oil and gas exploration are the uncertainties concerning the location, volume, and quality of hydrocarbon deposits as well as various other geological characteristics that can affect profits. These uncertainties expose firms exploring for oil and gas to considerable risk. Firms may invest substantial capital into exploring a particular area and fail to make a profitable discovery.

Exploratory drilling success rates in Alberta illustrate the costly nature of exploration. The majority of exploratory wells drilled between 1930 and 1968 in Alberta failed to find commercial volumes of oil or gas. Annual discovery rates ranged from a low of zero to a high of less than 35 percent. The expenditures associated with a dry well were not trivial. Hanson (1958) reported the cost of drilling a representative well in the Leduc–Woodbend oil field, in the 1950s, to a depth of about 5200 ft, to be \$494 thousand.¹ Knight (1956) reported that prior to its famous Leduc discovery, Imperial Oil had drilled 133

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http://dx.doi.org/10.1016/j.reseneeco.2016.05.003

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^{*} Many thanks go out to Harry J. Paarsch for his generous advice and many comments. I am also grateful to Herbert Emery for his insightful comments and for organizing research visits to the University of Calgary economics department; Jeffrey Church also helped organize research visits to the University of Calgary economics department for which I am grateful. I also wish to thank seminar participants at Yale University, Copenhagen Business School, University of Calgary, University of Alberta, University of Saskatchewan and the University of Stirling.

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¹ The cost is reported in real 2006 Canadian dollars and only includes the cost of drilling. The costs of completing the well and extracting any oil were not included.

dry-holes in Western Canada and spent over \$13 million on exploration.² The costly and risky nature of exploration suggests an important role for information.

Exploration produces two outputs: oil or natural gas as well as information. Consequently, exploration can be characterised as an information-gathering process (see Hendricks, 1983). Firms value any oil or natural gas that is discovered together with any information concerning the potential profitability of exploring or developing the surrounding region. To the extent that a region shares the same hydrocarbon-bearing geological features, a successful well drilled in the region signals that additional wells may yield more discoveries, whereas a sequence of dry wells may signal that the surrounding area may not have any commercially viable deposits. This informational aspect of oil and gas exploration suggests that the sequence of exploratory drilling in a region depends on the flow and stock of information. The fact that new information arrives with the completion of each well suggests that firms likely use sequential drilling strategies (see Hendricks et al., 1987).

The premise of this paper is that a firm's choice concerning whether to explore an area for oil or gas is influenced by the stock and flow of information. Firms evaluate the stock of information available for the different regions and choose which regions to explore to maximize expected profits. The flow of information from the new set of exploratory wells gets added to the existing stock and firms re-evaluate their investment strategies across regions. I investigate this information process using data on drilling outcomes of firms exploring for oil and gas in Alberta beginning in 1930. I study exploration effort beginning in 1930 because I can track drilling histories from what is essentially the beginning of sustained exploration effort in Alberta.

There is an interesting literature on the role of information in oil and gas exploration. This literature generally focused on two interrelated agendas. One agenda investigates the role of information in the bidding behaviour of firms competing for exploration leases. An objective of this line of research was to see if the observed bid data from auctions of offshore exploration leases were consistent with the predictions of models of first-price, sealed-bid, common value auctions. Most of the empirical studies analysed data from the auctions of leases on the Outer Continental Shelf (Porter, 1995 provides an interesting summary of the different studies analysing the data from these auctions). Important studies include Mead et al. (1984) and Hendricks et al. (1987) which report that bidding and return patterns differ between informed bidders and uninformed bidders (or between wildcat leases and drainage leases). Informed bidders were defined as those that owned leases adjacent to leases up for auction. Both studies report that leases which were won by informed bidders earned a higher return compared to leases won by uninformed bidders: It pays to be informed.

The other branch of research focused on role of information in exploration decisions (again, see Porter, 1995 for an excellent overview of the research analysing data from the exploration of the OCS). Hendricks and Porter (1996) find that offshore drilling activity in the Gulf of Mexico was characterized by U-shaped patterns: The number of tracts explored were initially declining in the number of quarters since the lease was acquired and then increased quite dramatically in the quarters prior to the lease expiring. They show that tracts with higher bids were more likely to be explored early in a lease period; however, as time progressed firms appeared to have been relying on the information in exploration outcomes to make their exploration decisions. The results in Hendricks and Porter (1996) suggest that firms were more likely to explore a lease in the first three years if a nearby lease was productive. Moreover, firms were more likely to explore a lease in the first two years if drilling activity was observed in the surrounding area.

In a more recent study, also using data from the OCS (Gulf of Mexico), Cynthia Lin (2009) found no evidence that firms responded to drilling activity in nearby leases. The empirical specifications estimated in Cynthia Lin (2009) included an indicator variable identifying whether an adjacent lease has been drilled. The specifications do not include an indicator of outcomes on nearby leases. In a related study, Cynthia Lin (2013) concluded that there was an information externality associated with oil and gas development, but not with decisions to explore. Overall, these two studies found only weak evidence of an information externality in offshore oil and gas exploration.

One reason that these previous studies found only weak evidence for the existence of information spillovers in exploration activity could be that the information signals in observing only drilling activity is not substantially different from observing a firm's valuation of a tract through winning bids (or other pre-sale information): firms do not learn much more from observing drilling activity than they already learned from pre-sale information. Moreover, the signals are binary in the sense that a lease owner observes whether an adjacent track was explored or not. The information externality is likely stronger with observing a progression of drilling outcomes rather than just activity. Onshore exploration is quite different from offshore exploration suggesting that information spillovers may have a different role in onshore exploration due to what firms can observe.

I contribute to this literature by examining the relationship between onshore exploration and information. Previous empirical studies largely analysed data from the offshore exploration of the OCS.³ Onshore drilling is quite different from offshore exploration. Onshore exploration is relatively more nimble than offshore drilling and simpler in terms of the required

² In 1947, central Alberta emerged as the centre of oil and gas exploration because of significant discoveries around the town of Leduc, located 33 km south of the provincial capital, Edmonton. The well that initiated the flurry of activity was the famous Leduc #1 well drilled by Imperial Oil Ltd. This discovery would prove to be the most important event in the Alberta oil and gas industry.

³ An interesting exception is the recent study by Kellogg (2014) which looks at the effect of price uncertainty in onshore oil and gas exploration. While the study does not specifically focus on information spillovers it still discusses an important factor affecting onshore exploration.

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