

NCS EXPLORATION SUCCESS RATES. EFFECTS OF COMPETITION AND DISTANCE TO INFRASTRUCTURE

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Overview

The paper makes two novel extensions to existing empirical research on exploration success. First, we address the trend by international oil companies preferring exploration close to existing infrastructure. New resources could be tied into existing infrastructure when production goes off plateau, securing low development cost. Drilling close to existing infrastructure may on average mean a better geological understanding of the reservoir and a higher success rate. Second, we address the effect of competition on exploration success, applying a proxy for competition intensity from the literature on industrial organisation (Herfindahl-Hirschman-index). Competition may stimulate innovation, creativity and diversity of ideas in exploration.

By applying econometric analysis on data from the Norwegian continental shelf (NCS), we will determine key drivers of exploration success rates.¹ To isolate the effects of competition and distance from exploration well to existing infrastructure, we apply control variables that are found to impact exploration success. The variables are geological age, drilling speed, year of drilling initiation, drilling depth, and lagged oil price. The reason for including these variables are as follows. Higher drilling speed leads to lower drilling cost (cost proxy), which may incentivise oil companies to take on more exploration risk. That typically has a lower technical success probability but a potential for larger reserves. Similarly, a high oil price, serving as a proxy for the companies' cash flow, may lead them to take on higher exploration risk. Time of drilling initiation reflects maturity of the shelf as well as technology improvement. Drilling depth is relevant as a deeper exploration well increases the probability of making a discovery.

Iledare and Pulsipher (1999) analyse reserve additions in the mature onshore Louisiana, 1977-1994. Forbes and Zampelli (2000) use an econometric model on offshore US data from 1978 to 1995 to disentangle and quantify major factors affecting the commercial exploration success rate. They find that key drivers are oil and gas prices, drilling depth (affecting drilling cost), hydrocarbon type, stock of unexplored acreage, and technical advances (represented by a trend variable). We complement this article by focusing on the technical success rate and the effect of competition and distance from infrastructure. Other extensions are introducing rig rates and drilling speed that are known to affect drilling cost (Skjerpen et al., 2018; Roll et al., 2012), distinguishing between wildcat and appraisal wells, and using a panel data set that covers the three regions on the NCS.

Methods

The aim of this study is to identify determinants of the exploration success rate on the NCS. Let y_i be a dichotomous variable equal to 1 if a wildcat wellbore i encounters hydrocarbons and 0 otherwise. With probability of technical discovery as the dependent variable, $Pr(y_i = 1)$, and a set of independent variables, the regression equation becomes

$$Pr(y_i = 1) = F\left(\beta_0 + \sum_{j=1}^k \beta_j x_{ji} + \varepsilon_i\right) = \frac{1}{1 + e^{-(\beta_0 + \sum_{j=1}^k \beta_j x_{ji} + \varepsilon_i)}}. \quad (1)$$

As the dependent variable is binary, it is necessary to utilize Maximum Likelihood Estimation (MLE) as the standard OLS approach would violate Kolmogorov's axioms of probability theory. The log-likelihood function, to be maximized, is as follows:

$$\ln L = \sum_{j \in S} w_j \ln F(X_j b) + \sum_{j \notin S} w_j \ln \{1 - F(X_j b)\}. \quad (2)$$

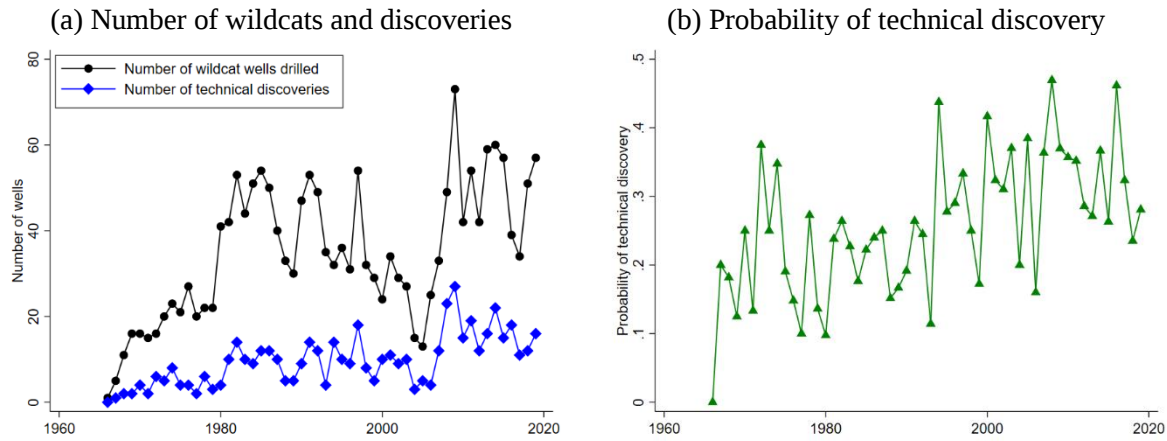
Our dataset consists of information on wellbore information from offshore exploration wells drilled on the Norwegian continental shelf (NCS) between 1966 and 2024. All information was provided by the Norwegian Offshore Directorate.

Results

We find that the technical success rate is increasing on the NCS.

Figure: NCS development in number of wells and exploration success.

¹ A discovery is a petroleum deposit or several petroleum deposits, which have been discovered in the same well, in which through testing, sampling or logging there has been established a probability of the existence of mobile petroleum. The definition covers both commercial and technical discoveries; <https://www.norskpetsroleum.no/en/facts/discoveries/>



Our analysis indicates that learning and effects and technological advances have dominated maturity on the NCS, so that the technical success rate is still increasing.

Conclusions

Maturity of the shelf would call for a lower success rate, whereas learning effects and technological advances will be expected to have the opposite effect. Decreasing oil price and factors that increase drilling cost can make oil companies more selective in their exploration efforts, due to capital rationing (Osmundsen et al., 2020), thus increasing the discovery rate. We will apply econometric methods to explain the variation in the technical exploration success rates over time. The explanatory variables are competitive pressure, distance from infrastructure, oil price, drilling speed, rig rates, drilling depth, an indicator for wildcat and appraisal well, a trend variable for technological progress, depletion (annual average percentage of original reserves of recoverable o.e. extracted from fields on the NCS), acreage announced, acreage awarded, and amount of seismic in km.

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