***key drivers of exploration success rates on the NCS***

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## Overview

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.[[1]](#footnote-1) The definition covers both commercial and technical discoveries. Research into the determinants of the success rate is essential for profitability of oil and gas companies. To determine key drivers of exploration success rates, our econometric approach involves running a logit regression with maximum likelihood estimation (MLE) on wellbore data from the Norwegian continental shelf (NCS).

Iledare and Pulsipher (1999) analyse reserve additions in the mature onshore Lousiana, 1977-1994, finding that while technical progress in exploration is considerable it was not able to fully compensate for depletion. They consider both exploration and development wells, and explain variations in added reserves. In their econometric model, among the explanatory factors are expected price of hydrocarbons, corporate income tax, severance tax, royalty, extraction and operating cost and the discount rate, and a time trend used as a proxy variable for technical progress.

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, by introducing rig rates and drilling speed that are known to affect drilling cost (Skjerpen et al., 2018; Roll et al., 2012) by using a data set that covers the entire history of the three regions on the NCS.

A total of 53 exploration wells were spudded on the NCS in 2018. More wells were drilled in the North Sea (31) and the Norwegian Sea (15) than in 2017, while there has been a decline in the Barents Sea (7).[[2]](#footnote-2) Both large and small exploration companies have contributed to the strong resource growth in the last few years. The Norwegian Petroleum Directorate has estimated the undiscovered resources on the Norwegian shelf at approximately four billion standard cubic metres (Sm3) of recoverable oil equivalents. This corresponds to around 47 per cent of all the remaining resources on the shelf.

## Methods

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

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| --- | --- | --- |
|  |  | (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:

|  |  |  |
| --- | --- | --- |
|  |  | (2) |

Our dataset contains wellbore information from offshore exploration wells drilled on the Norwegian continental shelf (NCS) between 1966 and 2019. All information was provided by the Norwegian Petroleum Directorate (NPD). During this time period, a total of 1925 wells have been drilled. Exploration wellbores are either wildcats or appraisal wells. Out of 1925 exploration wells, 1230 () are wildcats and 696 () are appraisal wells. Discovery was made in 514 of the 1230 () wildcat wells*.* 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 identify drivers of technical exploration success rates. The explanatory variables are oil price, drilling speed, rig rates, drilling depth, 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. A set of control variables capturing the characteristics of the wellbore is also included.

## Results

Pre-regressions results show that the technical success rate is increasing on the NCS. Based on an Augmented Dickey-Fuller test and Phillips-Perron test, the aggregate probability is found to be stationary around a deterministic trend. Preliminary regression results show several significant relationships.

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| Figure 1: **Aggregate development in exploration and success rate on the NCS (1966-2019)** | |
| (a) Number of wildcats and discoveries | (b) Probability of technical discovery |
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## Conclusions

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. There are several probability measures for exploration. One is technical success rates, i.e., whether petroleum is discovered. This is of a geological nature. Another standard probability that combines commercial and geological features is the probability that an exploration well leads to a discovery that is developed, i.e., the commercial success rate. There is also a third probability that puts more weight on the commercial side; the probability that the reservoir is developed, provided a technical discovery is made. In an extension of this paper, we will analyse the drivers behind variation in these success rates over time, and the relation between them.

## References

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1. <https://www.norskpetroleum.no/en/facts/discoveries/> [↑](#footnote-ref-1)
2. <https://www.norskpetroleum.no/en/exploration/exploration-activity/> [↑](#footnote-ref-2)