



Pro-cyclical petroleum investments and cost overruns in Norway[☆]



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ABSTRACT

Development projects in the oil industry often have cost overruns. Through analysis of data from Norwegian development projects in the petroleum industry, this paper investigates the common effect of business cycle developments on cost overruns. Lack of capacity and expertise in a tight supplier market yield cost inflation and difficulties in managing projects. Unlike previous analyses of cost overruns, we analyze projects over a long time period to capture the cyclical effects. We document a statistically significant positive relationship between oil price developments and cost overruns, and a positive relationship between changes in number of employees in the sector and cost overruns. We also show that surprises to the oil price during the project implementation having a larger impact on cost overruns than the oil price level itself. Cost overrun ultimately leads to reduced competitiveness for the industry, and we discuss consequences and policy implications for business and society of these cost overruns.

1. Introduction

This paper analyses cost overruns on petroleum projects in Norway related to realized and expected capital expenditure (capex). Little quantitative research exist on cost overruns in petroleum projects, and this paper is one attempt to improve upon this. For Norway, there are two reports on cost overruns on the Norwegian continental shelf (NCS). The first is a report written on behalf of the [Norwegian Petroleum Directorate \(2013\)](#) that considers 5 megaprojects on the NCS. The findings in this report were compared to [NOU \(1999\)](#), a similar report produced by the Investment Committee in 1998. Although there are 15 years between the two reports, the conclusions are similar. First, cost overruns are considerable in all projects considered. Across the 16 projects considered in the reports, an average cost overrun of 50.63% was identified. Second, cost overruns are often identified in early phases of a project. Third, underestimating uncertainty and unrealistic ambitions create too optimistic estimates for project cost and progress. This factor together with insufficient time for pre-engineering is the main reasons for the cost overruns experienced according to the two reports.

Unrealistic ambitions and too optimistic estimates are likely correlated with the current business climate. A failure to incorporate the total cost effect of aggregate industry demand for services related to projects is likely to lead to cost overruns when making individual project decisions and projections. To take drilling as an example, which

may represent up to 50% of the investments in a petroleum development project ([Osmundsen et al., 2010](#)), no oil companies foresaw the tripling (312% between 2000 and 2013) of rig rates at the Norwegian shelf, see [Fig. 10](#) below, combined with a large reduction in drilling productivity. [Osmundsen et al. \(2012\)](#) show that an increase in oil price leads to a decrease in drilling speed and [Osmundsen et al. \(2015a, 2015b\)](#) demonstrate that a higher oil price causes higher rig rates. The combined effect of increasing rig rates and decreasing drilling speed was an explosive increase in drilling cost. In the current downturn in the industry we see a dramatic fall in rig rates and receive reports of a large increase in drilling speed. The facts suggest that drilling cost are responsive to the business cycle. This is partly due to scarcity of certified rigs in boom periods. Partly one may argue that it is qualified personnel that represent the underlying scarce factor. Rigs are supplied with personnel, and wages are included in the rig rate. Other oil service companies and the oil companies also struggle to find competent personnel when all companies are recruiting at the same time.

In this paper, we study the effect of the business cycle on the accuracy of project cost estimates, using data from the Norwegian Continental Shelf (NCS). Our first hypothesis is that the business cycle of the oil industry is likely to affect the extent of cost overruns. There are several potential indicators for the business cycle to use in such an analysis. We make a distinction between global and local indicators, where the global indicators affect the entire oil industry while local indicators are particularly important for the Norwegian shelf. We use

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the oil price as an indicator for the current global industry business cycle and as an indicator for future income expectations.¹ Since cost overruns can be perceived to be associated with an unexpected oil price increase, we construct an oil price surprise variable, defined as the relative difference between the current oil price and the oil price at the time of the project sanctioning. This is used as our global business cycle explanatory factor. As explanatory factors for the local business cycle, we apply employment surprise, investment surprise, wage surprise and surprise in rig rates in new contracts on the NCS. Investment and employment refer to the overall activity in the Norwegian petroleum sector, where a high level typically is associated with lower average input quality and bottlenecks at various parts of the value chain. This brings us to our second hypothesis, whether cost overruns are more responsive to global or local business cycle indicators. After the last large incidence of cost overruns in the 1990s, oil companies reported to the Investment commission (NOU, 1999:11) that lack of competent personnel and insufficient internal project management resources were their primary concern. Thus, our second hypothesis is that local business cycle parameters are most important in explaining cost overruns.

Our analysis provide useful input to cost estimation. The Norwegian government report on cost overruns of projects in the North Sea (NOU, 1999:11) concluded that there was a 26% increase in development costs from project sanction (PDO, Plan for Development and Operation) to last CCE (Capital Cost Estimate) for the 11 oil field projects investigated. Many reasons like unclear project assumptions in early phase, optimistic interpolation of previous project assumptions, too optimistic estimates, and underestimation of uncertainty were given as reasons for overruns.

Emhjellen et al. (2002) highlight the possibility that the cost overruns can also be related to an error in the estimation and reporting of capex. Usually the capex is given by a single cost figure, with some indication of its probability distribution. The oil companies report, and are required to do so by government authorities, the estimated 50/50 (median) cost estimate instead of the estimated expected value cost estimate. Emhjellen et al. demonstrate how the practice of using a 50/50 (median) capex estimate for the 11 projects when the cost uncertainty distributions are asymmetric, may explain at least part of the “overruns”. Hence, the authors advocate changing the practice of using median cost estimates in favor of expected value cost estimates for project management and decision purposes. We augment their findings by demonstrating that an important and often underestimated cost driver is the effect of the business cycle. Lack of capacity and expertise in a tight supplier market yield cost inflation and difficulties in managing projects. Unlike previous analyses of cost overruns, we have analysed projects over a long time period so that we capture cyclical effects.

Previous empirical research on investment patterns in the Norwegian petroleum sector is related to exploration, see Mohn and Osmundsen (2008, 2011). We look at the major component of petroleum investment – development projects. Fluctuations in development investment in response to changes in oil and gas prices are considerably smaller than for exploration spending – partly because longer lead times and low success rates make exploration more risky and thus more price sensitive, and partly because exploration unlike development can be reduced at short notice.

Flyvbjerg et al. (2003) study cost overruns in public megaprojects, and find that optimism bias and strategic misrepresentation lead to poor decision basis. Consequently, overoptimistic projects are chosen due to their underestimated costs and overestimated revenues. Moreover, since a megaproject is big by definition, it is difficult to

cancel after it has been initiated due to already heavy investments. As such, Flyvbjerg et al. find that even substantial cost overruns are ignored in order to complete the project. Some of these characteristics of public megaprojects may also be true for megaprojects in the petroleum industry, and short-term and long-term considerations need careful balancing in order to ensure beneficial development and to avoid pro-cyclicality.

Policy makers in oil exporting countries need to consider the incentives for successful implementation of petroleum projects. This is crucial to the industry where marginal cost is expected to increase over time due to complexity of unconventional oil, and several recent papers (van Moerkerk and Crijns-Graus, 2016; Speirs et al., 2015; Bentley and Bentley, 2015) argue that oil supply will be tight in the future. Owen et al. (2010) review the status of conventional oil reserves and suggest that commercially exploited oil is limited and will decline. This is also the conclusion in Benes et al. (2012) whom address the limits to geology as easy and conventional oil reserves are reduced, and the possibilities of technological developments to reduce cost from unconventional and complex oil reserves. Oil supply involves all countries globally and energy security is discussed in several papers (Helm, 2002; Yergin, 2006; Stirling, 2010; Yang et al., 2014). North America, Europe and Asia-Pacific have been dependent on oil imports, while the Middle East has provided supply of oil through its abundance of oil resources. To increase future energy security, the world relies on projects with lower cost overruns than typically experienced today. First, this will create profitability for the exporting countries. In addition, and perhaps more importantly, for importing countries profitable projects will provide oil at a lower cost. For the petroleum industry, cost overruns lead to reduced profitability, and ultimately to reduced competitiveness. Poorly implemented projects require higher capital reserves and consequently increase the cost of capital.

According to Merrow (2011, 2012), the petroleum industry is particularly poor at delivering at budget and on time. The success rate in the petroleum industry is only 25% and Merrow (2012) argues that one key reason is the petroleum industry's high turnover in project leadership. Moreover, Mishra (2014) at IPA, indicates that projects undertaken on the Norwegian continental shelf (NCS) perform worse than comparable projects undertaken in the Gulf of Mexico (GoM). Their report shows that Norwegian projects less frequently use repeated designs, which are standardized design used in several projects. Other previous studies on NCS relates to drilling and efficiency (see, for example, Mohn and Osmundsen (2008, 2011) and Mohn (2008)).

While several papers address the importance of technological and governmental regulation of oil and gas production and extraction, our paper will provide insights on the managerial challenges in securing a stable oil and gas supply as addressed in Andriosopoulos et al. (2016). Cost overruns are inefficient and policy development and monitoring is equally important as forecasting and risk management for a company developing oil and gas fields. Moreover, uncertainties about the closing cost adds capital cost to the operating company, thus limiting the company from undertaking other profitable projects. Finally, with increasing environmental demands and the remoteness of reserves, the complexity of future projects is likely to increase, emphasizing the importance of policy and incentives for decision-makers to generate efficient projects.

We will investigate projects on the Norwegian continental shelf (NCS) going back to 2000, and compare cost overruns to our proxy for the business cycle. We use yearly data from Ministry of Petroleum and Energy, provided by license holders/operators on NCS that are required to provide a yearly report on actual cost and cost estimates for development projects. Our main finding is that cost overruns are higher, in relative terms, when oil prices and other proxies for economic activity increase during project implementation. As such, the industry may be pro-cyclical. Furthermore, economic activity variables of a local origin, especially sector employment on the NCS,

¹ The price of oil is difficult to forecast over longer periods (Hamilton, 2009), and due to long lead-time from investment commitment to production start, uncertainty is substantial for any project in the petroleum industry.

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