Energy 133 (2017) 1094–1107

Contents lists available at ScienceDirect

Energy

journal homepage: www.elsevier.com/locate/energy

Cost overruns on the Norwegian continental shelf: The element of surprise☆

Sindre Lorentzen*, Atle Oglend, Petter Osmundsen

University of Stavanger, NO-4036, Stavanger, Norway

ARTICLE INFO

Article history:
Received 3 May 2016
Received in revised form
8 May 2017
Accepted 16 May 2017
Available online 18 May 2017

Keywords:
Project metrics
Project valuation
Oil projects

ABSTRACT

We examine drivers of cost overruns in Norwegian development projects in the oil and gas sector. The multivariate longitudinal econometric analysis employs a unique and detailed dataset consisting of 79 different projects between 2000 and 2013. Among the significant results, we find that the unexpected change in economic activity has a positive effect on the overruns, there is a considerable positive momentum in the transitional cost overruns, more experienced operators tend to incur less overruns and finally that the size of the investment of the projects has a positive impact on the overruns. Furthermore, we find evidence that current economic activity matters to an extent, but that the pivotal factor is the unexpected change in activity.

1. Introduction

Delivering at or below the estimated cost is considered a pivotal criterion, alongside quality, delivery on schedule and production attainment, for evaluating the success of project execution. A cost overrun, defined as the inflation-adjusted deviation between realised and estimated costs, may provide some information about the quality of the ex ante decision to undertake the project in question. Evaluating the available set of investment opportunities and actively determining which projects to implement represent a core activity for companies. The desirability of a particular project is evaluated by companies on the basis of the profitability metric they use, such as net present value (NPV) or the internal rate of return. If an oil and gas company is cash constrained, it will use a profitability metric which allows for capital rationing, such as the NPV index or the break-even price (often supplemented by other criteria like production targets and strategic issues). Taking this approach allows a company to achieve an optimal allocation of available capital. Where cost estimate bias is present, however, the profitability ranking of the investment opportunity set will be distorted and the company will allocate capital sub-optimally. Cost estimate bias is detrimental to the value of companies, and reducing it would allow companies to make better-informed decisions which thereby generate more value.

Cost overruns have been extensively examined in the literature. See Ref. [10] for an excellent overview. Prior to the seminal work of Flyvbjerg, however, the research was predominantly non-empirical. Flyvberg's papers [15–18] introduce crucial empirical insights through highly relevant case studies in public transport. In this paper, we extend his work to the oil and gas industry and also complement his empirical methods. Whereas he applies univariate cross-sectional regressions with few explanatory variables, we utilise a more rigorous methodology with longitudinal multivariate regressions. We benefit from a unique and detailed data set on oil projects in Norway, where oil companies are required to make detailed and frequent project reports to the government. Our data come from the national budget and the Norwegian Petroleum Directorate (NPD).

The purpose of this research is to provide insight regarding offshore projects on the Norwegian continental shelf (NCS) by attempting to identify a model with explanatory power for the cost overruns so that companies can be equipped with tools to make better investment decisions. The contribution of this paper is as follows: (1) we analyse a sector which is relatively untouched in the literature on cost overruns and (2) we utilise a more rigorous methodology with longitudinal multivariate regressions. A wide range of variables are applied as regressors. We test, for example, various proxies for the level of economic activity, proxies for technical project complexity, project ownership characteristics and

☆ We thank the editor and two anonymous referees for constructive comments. Funding from the Research Council of Norway (Petrosam 2) is appreciated.

* Corresponding author.
E-mail addresses: sindre.lorentzen@uis.no (S. Lorentzen), atle.oglend@uis.no (A. Oglend), petter.osmundsen@uis.no (P. Osmundsen).

http://dx.doi.org/10.1016/j.energy.2017.05.106
0360-5442/

operator experience.

The remainder of this paper is organised in the following way. Section 2 presents the literature and theoretical motivation for variable selection. Section 3 elaborates on the data utilised and presents descriptive statistics. Section 4 presents econometric results. Finally, Section 5 summarises and concludes.

2. Literature review

We start by presenting a general theory of cost overruns. Thereafter, we present literature specific to the oil industry and the NCS. Several prominent theories attempting to explain cost overrun can be found in the literature. According to [15]; the plethora of cost overruns which have emerged from the literature can be classified into four distinct categories of theories: technical, economic, psychological and political.[1]

Following the reasoning of [15]; the technical approach to explaining cost overruns postulates that higher-than-expected cost is a function of both bad luck and random forecasting errors attributable to imperfect methods and data. Examples of technical cost overrun theories are managerial incompetence [5,19,33,39,40,42], claiming that cost overruns are caused by random error or mistakes from the project management; contract form theory [2,36]; project complexity [41]; and scope creep or evolution theory [20,31,32]. If cost escalation can be attributed to technical aspects, [15] argues that negative and positive cost overruns should be equally likely. In other words, the bias to the point estimate behaves similar to a Gaussian white noise process and the distribution of overruns should consequently be symmetric and be centred, on average, around zero. Furthermore, since forecasting and estimating techniques incrementally improve as experience is accumulated, the average size of the overruns should be declining over time and converging towards zero. As we explain below, symmetry is not representative of the petroleum industry.

Where the economic theory of cost overruns is concerned, the existence of an economic incentive for the agents estimating costs to understate the costs deliberately has been postulated. Assuming this to be true, the expectation is that the distribution of cost overruns should be asymmetrical and the mean time invariant. Prominent theories within this category is the economic self-interest and public interest theory [16].

The psychological theories regard a cost overrun as the effect of cognitive bias and faulty decision-making heuristics in the mind of the agent doing the estimating. As with the economic approach, the psychological explanation predicts that the distribution ought to be asymmetrical. Unlike with economic thinking, however, the mean should approach zero as these biases become more elucidated and better understood. For instance, optimism bias or planning fallacy theory [8,14,27,28,35,56] and prospect theory [29] belong to this category of cost overrun theories.

Finally, the political explanation is similar to the economic one in the sense that the cost overrun is believed to be the result of deliberate deception motivated, as its designation implies, by political rather than economic reasoning [54,58,1,7,15,19,46,55]. As a result, predictions regarding distribution are equivalent to those generated by the economic approach.

A consensus prevails that complexity is one of the main cost overruns drivers [37] and it has generally been established that cost overruns increase with complexity. This positive correlation between complexity and project performance could have several interpretations. It could be the case, for example, that the absolute level of complexity is not necessarily what matters, but the unexpected level of complexity which project managers encounter during project execution. [52] argue that such underestimating increases with the degree of complexity, so cost overruns should be more frequent in complex projects. Second, [22] find that people tend to be more overconfident when estimating complex tasks and, conversely, less confident with comparatively simpler tasks. Complexity is a broad concept, and could encompass a variety of different aspects. To address this point of view, [3] disaggregates complexity into technical and organisational dimensions. Technical and organisational complexity may affect project cost overruns to varying degrees. According to [6]; for instance, companies tend to invest more effort in addressing technical complexity than complex organisational issues such as coordination and timing. Companies might consequently be less prepared to handle the latter when they emerge.

Complexity of the task is arguably just part of the explanation for cost overruns. The competence of the project management is likely to be an additional determinant. As such, the ability of companies to predict future costs can be viewed as the amalgam of both the complexity of the project and their expertise and experience. Competence is generally challenging to quantify, but [47] report that the experience of management matters.

The explanatory variable most frequently utilised for cost overruns is project size. That probably reflects the independence of this variable from context – that is, project size is applicable regardless of the sector under consideration. In many ways, the size of the project's investment might be regarded as a proxy for its complexity. The ex ante expectation is consequently that larger projects should incur more cost overruns. However, the literature appears to present conflicting findings on the empirical effect of size on project cost overruns. [21,23]; Hatton (2007), [38]; Sauer et al. (2007), [57] and [12]; for instance, find a positive relationship between the two aforementioned variables. However, [4,11,24,41] and [9] identify a negative relationship. Finally, [53] and [17] find no relationship significantly different from zero. [26] offers a possible explanation for the observed differences in the literature. In their view, these can partly be explained by variations in the proxy for project size. The literature tends, for example, to use the ex ante estimated project cost and the ex post realised cost interchangeably. However, these two proxies might not be perfectly correlated, and the empirical effect of project size might consequently tend to differ across measures.

We now turn to the literature specifically relevant to the petroleum sector. While cost overrun theories provide insight into the dynamics of why deviations from budget emerge during project execution, most theories are formulated context-free without any particular industry as a basis. Variables such as project complexity might be a pivotal driver of cost overruns, but the proxies used to measure complexity within an empirical study are dependent on the particular industry. An excellent study by Ref. [30] identifies several pivotal drivers of offshore drilling costs. According to Kaiser, drilling activities tend to represents between 40 and 60% of capital expenditure in offshore field development. As argued, the physics and core concept of drilling offshore wells are the same across the world, but the cost will depend extensively on both complexity and type. Some of Kaiser's identified drivers of cost are, for instance, well characteristics (well type, total depth, vertical interval, horizontal displacement, well geometry, number of casing strings, formation pressure, well temperature), site characteristics (water depth, distance to shore, region/country, soil, wave, current conditions), formation evaluation, market conditions, environmental conditions (weather, wave, current, eddies, storms) and geologic

[1] Flyvbjerg has refined the categorisation of root causes for cost overruns theories in later publications. The technical category was changed to "bad luck or error", psychological to "optimism bias" and the economic and political categories were merged into "strategic reporting".