Cost overruns on petroleum projects. The effect of project size

Sindre Lorentzen, University of Stavanger, sindre.lorentzen@uis.no
Petter Osmundsen, University of Stavanger, petter.osmundsen@uis.no

Overview

Ernst & Young (2013) reports average cost overruns of 64% on global megaprojects in the oil and gas industry. In the general literature on cost overruns, project size is the most frequently used explanatory variable in econometric modelling. However, project size has proven itself to lend inconsistent results in the previous literature by splitting between positive (Dantata et al., 2006; Dahl et al., 2017), insignificant (Flyvbjerg et al., 2004; Van Oorshot et al., 2005) and negative effect (Creedy, 2006; Hill et al., 2000). In this article we attempt to shed light on this non-conforming consensus by testing for a non-linear relation between cost overruns and project size. A nonlinear relation between cost overruns and project size is what we find when we plot our dataset; 160 oil and gas development projects between 1988 and 2016 on the Norwegian continental shelf.[1]

Methods

Cost overruns in projects has been studied extensively throughout the decades. However, this research has been predominantly contained to performing case studies of a limited sample. Among studies applying a more empirical approach, the econometric methodology restricted to univariate ordinary least square (OLS) regressions is commonplace. As pointed out by Jørgensen et al. (2012), the empirical literature has not formed a consensus regarding the effect of project size on cost overrun. Our hypothesis is that a potential driver of the non-conforming consensus regarding the relation between cost overrun and projects size is that there is a nonlinear relation. If there indeed is a nonlinear relationship, then samples confined to different segments of project sizes might yield differing results regarding the sign and size of the beta. We address this possibility by applying a multivariable fractional polynomial model, see Royston and Altman (1994).

Results

The results of our nonlinear econometric specification conform with the data plot. The overall picture contains a negative sloped section, i.e., where increased project size reduces the problem of cost overruns, a flat section, and a positive section where the opposite holds true. Thus, the findings of the current literature are special cases of our overriding, non-linear approach. The shape of the curve is the result of a trade-off between several essential cost drivers and modifiers. From a series of meetings with oil companies and contractors, we have ascertained the following two main determinants of the nonlinear relation:

1) Diversification. Larger projects can be considered as a portfolio of many small projects. Through diversification, the idiosyncratic risk is reduced or removed in larger projects. This might explain the larger variability in cost realisations for smaller projects and the opposite for large projects. Thus, this is an argument for a decreasing schedule.
2) Complexity. Project size serves as a proxy for project complexity, which is an argument for larger projects having larger cost overruns, i.e., an increasing schedule. Larger

[1] Data was extracted from the Norwegian Petroleum Directorate, Investment Committee, Office of the Auditor General of Norway and the Norwegian National Budget.

projects rely on critical co-ordination between different subprojects, often manufactured in different countries, thus increasing the probability of overruns.

The convexity of cost overruns versus project size can thus be seen as a trade-off between diversification and complexity. When the size of a project increases, there is the benefit of diversification, thus reducing the cost risk. We are now on the downward sloping part of the schedule. When project size increases further, the diversification affect is dampened and the complexity effect kicks in. After a while the complexity effect dominates, and we are on the increasing segment of the curve The effect of complexity on cost overruns exhibits diminishing returns, which thereafter causes the schedule to become concave; a truly non-linear relationship.

Conclusions

Our nonlinear specification is able to solve the puzzle of inconsistent results on the relation between cost overruns and project size. In our conversations with oil companies and the construction industry we were made aware of additional factors that may help explain why the curve does not have a regular U-shape. One insight is that experience could represent an omitted variable. Inexperienced operators tend to undertake smaller projects compared to more experienced operators. This may help to explain the larger cost overruns for smaller projects, but also helps to explain why larger and presumably more complex projects are not associated with exponentially increasing cost overruns, as the largest projects on average are implemented and operated by the most experienced and resourceful companies.The experts also ask us to pay attention to the disaggregation of projects in the data set. A project with a large cost overrun is more probable to be rejected or stopped when it is a stand-alone project compared to it being a crucial part of a larger project. If a small and critical project is part of a larger project, but defined and accounted for as an individual project, the cost overrun may be insignificant seen from the perspective of the large project. What counts may be to deliver on time, so speed is the priority. Cost control may be at a higher priority of the larger parts of the project. This may explain larger cost overruns on some small projects.

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