

Cost overruns on petroleum projects. The effect of project size

Sindre Lorentzen, University of Stavanger,
4036 Stavanger, Norway
e-mail: sindre.lorentzen@uis.no

Petter Osmundsen, University of Stavanger,
4036 Stavanger, Norway
e-mail: petter.osmundsen@uis.no

Abstract

Cost overruns on oil and gas projects are a common. Due to limited data availability, project investment size has become one of the few frequently used explanatory variables in econometric modelling of cost overruns. However, project size has proven itself to lend inconsistent results in the literature by splitting between positive, insignificant and negative effect. In this article, we attempt to shed light on this non-conforming consensus by suggesting an overriding non-linear model. Our dataset consists of 160 oil and gas development projects between 1988 and 2016 from the Norwegian continental Shelf. With locally weighted regression and multivariate fractional polynomial modelling we find evidence of a nonlinear relationship between cost overrun and project size. We find an initial declining relation between cost overruns and projects size, which later reverts into an increasing but marginally declining relation. We find that this shape of the curve is the result of a trade-off between several essential cost drivers and modifiers, for instance, diversification and complexity.

1.0 Introduction

This paper investigates the empirical relationship between cost overruns and project investment size. This is achieved using data on cost overruns in offshore oil and natural gas development projects on the Norwegian Continental Shelf (NCS). 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. Cost overruns, to the extent they represent a cost estimation bias, can have a negative impact on profitability through causing a distortion in the profitability ranking of the companies' portfolio of available investment projects – which can lead to non-optimal decisions.

Cost overruns in projects have 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 tends to be simplistic – i.e. univariate ordinary least square (OLS) regressions are commonplace. This is likely due to the difficulty in getting access to data. The perhaps most frequently used explanatory variable in econometric studies is project size. This might be due to the fact that the estimated and realized size of the project are required to compute the cost overrun in the first place, hence it is easily available. From a theoretical perspective, project size is often regarded as being a proxy for the complexity of the project. More complex projects are regarded as more difficult to control and plan for, thus there ought to be more cost overruns. However, the empirical literature has not formed a consensus regarding the effect of project size on cost overrun. While many studies indeed find a positive relation, a significant proportion of other studies finds either an insignificant relation or a negative relation between these variables.

In this article, we assess the relation between cost overruns and projects investment size by utilizing a more rigorous econometric methodology which allows for nonlinearities. Specifically, in our econometric approach we utilize locally weighted regressions and multivariable fractional polynomials. We hypothesize that there are nonlinearities in this relation, which are caused by several underlying determinants such as diversification, complexity, project aggregation and heterogeneity in operator experience. If there indeed is a nonlinear relationship, then samples confined to different segments of projects size might yield differing results regarding the sign and size of the beta.

The remainder of this article is structured as follows. Section 2 reviews previous literature on cost overrun and project size. The data is presented in Section 3. Results from the econometric analysis are presented and discussed in Section 4 and 5. Finally, Section 6 concludes.

2.0 Literature Review

The oil and gas sector is of pivotal importance for the Norwegian economy. With a large contribution to GDP and megaprojects with the potential of large environmental impact, the sector is constantly under scrutiny by many governmental and nongovernmental organizations. Regarding cost overruns in oil and gas projects on the NCS, there are several noteworthy studies. For instance, the Investment Committee (appointed by the Ministry of Petroleum and Energy) conducted a detailed examination of 13 projects on the NCS between 1994 and 1998. Further, Norway's Office of the Auditor General conducted similar analysis of three different projects selected from 1995 to 1996 and the Norwegian Petroleum Directorate draws a sample of five projects from 2006 to 2008. While these reports are case studies and thus offers little support on establishing an empirical relation between cost overrun and project size, they offer valuable insight regarding the dynamics of project execution on the NCS. Based on these reports a consensus appear to have been established regarding some of the drivers of cost overruns. First, the initial project plans and budgets appears to be riddled with unrealistic assumptions driven by excessive optimism. This finding is not unique to the NCS, Flyvbjerg et al. (2004) note similar results for transportation infrastructure projects. Second, project management had an inadequate and insufficient understanding of the risk and uncertainties related to the projects. Third, insufficient planning prior to project execution. Fourth, underestimation of the availability of bottleneck resources such as rigs and skilled workers. Finally, failure to take into account challenges represented by advances in technology.

More rigorous empirical approaches have been applied to cost overruns on the NCS in Dahl et al. (2017), Oglend et al. (2016) and Lorentzen and Osmundsen (2016). Based on their research, cost overrun appears to be rule rather than the exception. Based on panel data regression a significant relation between cost overruns and the business cycle is found. Worth noting, it appears that while economic activity has a significant impact, what really matters is the extent to which the change in economic activity is unexpected. Further, while cost overruns on the NCS appears to be prevalent both in frequency and extent, Lorentzen and Osmundsen show that cost overruns on the NCS is not worse than overruns in other sectors and countries.

Taking a step back from the oil and gas industry on the NCS, Table 2 shows a selection of different articles on cost overruns and project size. As observed, all outcomes ranging from significant to insignificant and positive to negative relation between cost overrun and project size have been obtained in the empirical literature. Interestingly, as pointed out by Jørgensen et al. (2012), estimated project size tends to give negative coefficients while realized size tend to result in positive coefficient. Further analysis by Jørgensen et al. (2012) show that applying alternate project size proxy rarely results in conforming conclusion regarding the relation. As further demonstrated by their research, the conflicting results appears to be, at least partly, driven the statistical artefact of imperfect correlation between estimated and realized investment size of the projects.

Table 1: **Literature review**

Research on the relation between cost overrun and project size. Article, project size proxy (either estimated or realized), sample size, type of project and the observed relation between cost overrun and project size is reported. Additionally, the analysis was repeated on the dataset from several of the articles by Jørgensen et al. by using the alternate proxy.

Author	Proxy	Sample size	Project	Relation
Creedy (2006)	Estimated	231	Road	↓
Dantata et al. (2006)	Actual	37	Rail	↑
Flyvbjerg et al. (2004)	Estimated	131	Rail	—
Gray et al. (1999)	Actual	77	Software	↑
Hatton (2007)	Actual	957	Software	↑
Heemstra & Kusters (1991)	Actual	388	Software	↑
Hill et al. (2000)	Estimated	506	Software	↓
Moløkken-Østvold et al. (2004)	Actual	42	Software	↑
Odec (2004)	Estimated	620	Road	↓
Pickrell (1989)	Estimated	10	Rail	—
Sauer et al. (2007)	Actual	412	IT	↑
Van Oorshot et al. (2005)	Estimated	108	Software	—
Yang et al. (2008)	Actual	112	Software	↑
Oglend et al. (2016)	Actual	79	Petroleum	↑

Based on the researched reported in Table 2, when regressing cost overrun on project size, it is linear relations that are almost exclusively tested. However, in the presence of a non-linear dependence, restricting the model specification to linear regression model might yield misleading results. We find two noteworthy examples of allowing for nonlinearity. In Oglend et al. (2016) cost overruns for petroleum projects on the NCS is considered. For testing of for a relationship between cost overrun and the realized project size, they improve the explanatory power by taking the inverse of project size. Project size is found to have a positive and significant effect on cost overruns. In Sovacool et al. (2014) electricity production projects are considered. Applying simple polynomials and logarithmic trends to various projects types (nuclear, hydro, wind, solar, etc.) they identify significant nonlinear relations for some of the project types.

3.0 Data

Our dataset consists of 160 offshore oil and gas projects between 1988 and 2016 on the NCS. Data was extracted from the Norwegian Petroleum Directorate, the Investment Committee, Office of the Auditor General of Norway and the Norwegian National Budget. We define cost overruns for a given project i as the inflation adjusted relative difference between the ex ante estimated project investment size (PDO_i), at the time of the project sanctioning, and the ex post realized project investment size ($CCEx_i$). The project size is measured in billion NOK at the time of the project sanction. See Equation (1) for the operationalization of cost overruns.

$$CostOverrun_i = \frac{CCEx_i}{PDO_i} - 1 \quad (1)$$

While the timing can be contested, the last available estimation prior to sanctioning is used in order to ensure that cost overrun is relevant for evaluation of decision-making – which appears to be the consensus in the literature. Cost overruns are informative of cost estimation bias and project managers' ability to execute projects according to plans. However, it should be noted that cost overrun as a measure possesses several shortcomings. For instance, if the scope of the project changes then the initial estimate becomes invalidated and the overrun becomes biased. Further, cost overrun is a one-sided focus on the cost side of the projects and fails to consider the income aspect of a project, timing and strategic considerations.

4.0 Empirical analysis

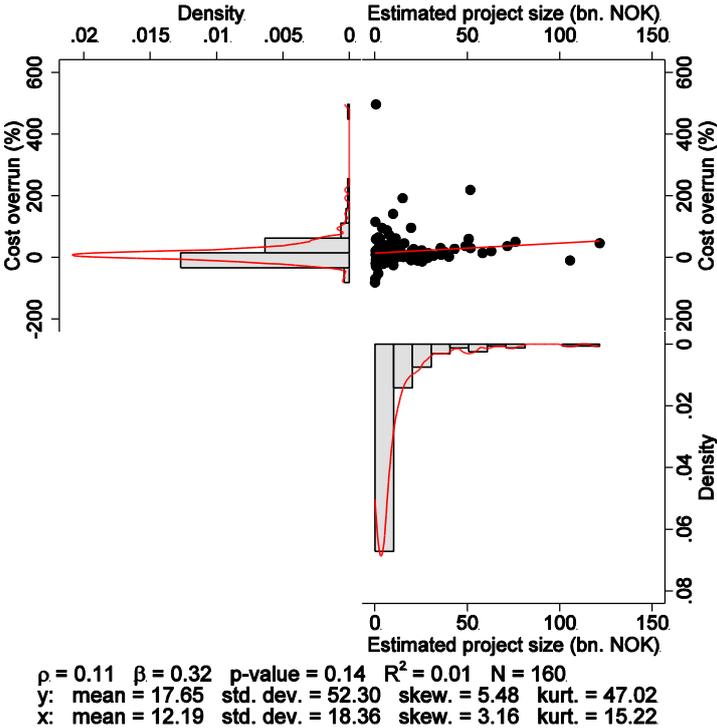
As a point of departure, we begin our analysis by applying an Ordinary Least Square (OLS) regression with cost overrun as the dependent variable and project investment size as the independent variable. The regression model is specified in Equation (1).

$$CostOverrun_i = \alpha + \beta \cdot ProjectSize_i + u_i \quad (1)$$

Figure 1 shows the regression results and corresponding distributions of the dependent and independent variables. As observed, the distribution of cost overruns exhibits both a positive mean and positive skewness, which suggests a deviation from the normal distribution. A Jarque-Bera normality test confirms that cost overruns are not normally distributed (p-value = 0.00). Offshore development projects have an average cost overrun of 18 per cent. As implied by both the mean and skewness, more projects are realized with overruns than underruns – specifically 114 out of 160 or 71 per cent of the projects overspent their budget. These results show that cost overruns are the norm rather than the exception. Dahl et al (2017) and Oglend et al (2017) find similar results for cost overruns on offshore oil and gas development projects on the NCS. Analogously, Flyvbjerg et al. (2004;2005;2006) and Sovacol et al. (2015) reach similar conclusions for transport infrastructure projects, electricity production and distribution projects. It should be noted that cost overruns are here derived from a point estimate. However, it is commonplace for firms to operate with a contingency budget. As such, an overspending constituting a cost overrun might not cause any issues during project executions if it is within the contingency budget. The various petroleum companies use different confidence levels for their point estimates, but with a contingency budget of 20 per cent above the estimate, as much as 31 per cent of the projects experienced cost overruns beyond this level. Further, project size appears to follow a lognormal distribution, this is further confirmed by a Shapiro-Wilk test as the null hypothesis of lognormality is not rejected (p-value = 0.94).

Based on regression results, the relation between cost overrun and project size appears to be insignificantly (p -value = 0.14) different from zero. This finding suggests that there is no linear relation between these two variables. Either the lack of significant results is caused by a genuine lack of relation between cost overrun and projects size, or that the econometric approach is unable to capture the relation due to a violation of OLS assumptions. Examples of the latter is heteroscedasticity and statistical outliers. With a Breusch–Pagan and Cook–Weisberg tests we find evidence of heteroscedasticity in the dataset (p -value = 0.07). The presence of statistical outliers is further confirmed by applying a leverage versus residual test to the regression model from Equation (1). An alternative explanation to the lack of a significant relation between cost overrun and project size is a misspecification of the functional form. In other words, there might be a nonlinear relationship between cost overrun and project size. To assess this possibility, we apply two different approaches: (1) an iterative locally weighted regression, and (2) multivariable fractional polynomial. Both methods are complementary but possess different strengths and weaknesses. The former can be considered more as a data filtering technique but can be a good point of departure for later model fitting. The latter follows the more traditional econometric model fitting methodology. We apply both to ensure robustness of the results, which is achieved when both approaches conform in their results.

Figure 1: Relation between cost overrun and project size for oil and gas projects on the NCS



Scatter plot showing relation between cost overrun (%) and project size (bn NOK) with a fitted regression line. The distributions are approximated through a histogram and Epanechnikov kernel density plot. Data consist of 160 offshore oil and gas projects between 1988 and 2016 on the NCS

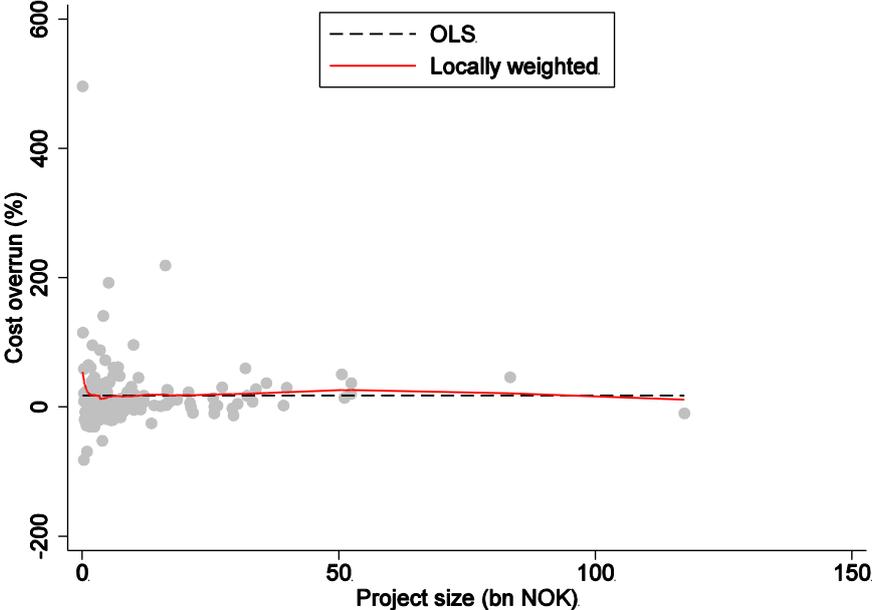
To assess the possibility of nonlinearity between cost overruns and project size, we begin by applying a locally weighted smoothing procedure to the data. This is accomplished by running a regression for each pair of observations ($ProjectSize_i, CostOverrun_i$) of cost overrun and project size as the central point and a few surrounding observations. The subsample used at each iteration of the smoothing procedure ranges from $\max(1, i - k)$ to $\min(i + k, N)$, where the parameter k is given

by $[(N \times bandwidth - 0.5)/2]$. The weighting (w_j) is based on Cleveland's (1979) tricube weighting function, where observations farther away from the central point receive a lower weight based on the distance absolute distance from the central point ($|ProjectSize_j - ProjectSize_i|$). The weighting function is given in Equation (2).

$$w_j = \left\{ 1 - \left(\frac{|ProjectSize_j - ProjectSize_i|}{\Delta} \right)^3 \right\}^3 \tag{2}$$

Figure 2 compares the OLS regression line to the smoothed line obtained from the locally weighted regression. As observed, the locally weighted regression line appears to deviate from the OLS regression line. This suggests that there might be nonlinearity in the relation between cost overruns and project size. The locally weighted regression line appears to exhibit three phases. First, it is initially declining at the lower percentiles of project size. Second, at the midsection of project size, the regression line then reverts and begins to increase at a declining rate. Finally, at the higher percentiles of project size the regression line begins to weakly decline.

Figure 2: Locally weighted scatterplot smoothing for cost overruns and project size



Based on the preceding findings obtained from the locally weighted regressions, there is some evidence to suggest a nonlinear relation between cost overruns and project size. To investigate this possibility further, we apply a multivariable fractional polynomial model approach. Rather than obtaining a set of N disjointed predictions, the MFP approach provides a single regression model with a functional form that balances the trade-off between in-sample explanatory power and specification parsimony. Fractional polynomials are derived from raising the independent variable to a power from the following set of exponents: $\{-2, -1, -0.5, 0, 0.5, 1, 2, 3\}$. Based on the defined fractional polynomials, the final model is specified by backward elimination. This methodology is robust to model fitting challenges caused by concavity and collinearity between the variables. See Royston and Altman (1994) for further details.

Figure 3: **Multivariable fractional polynomial**

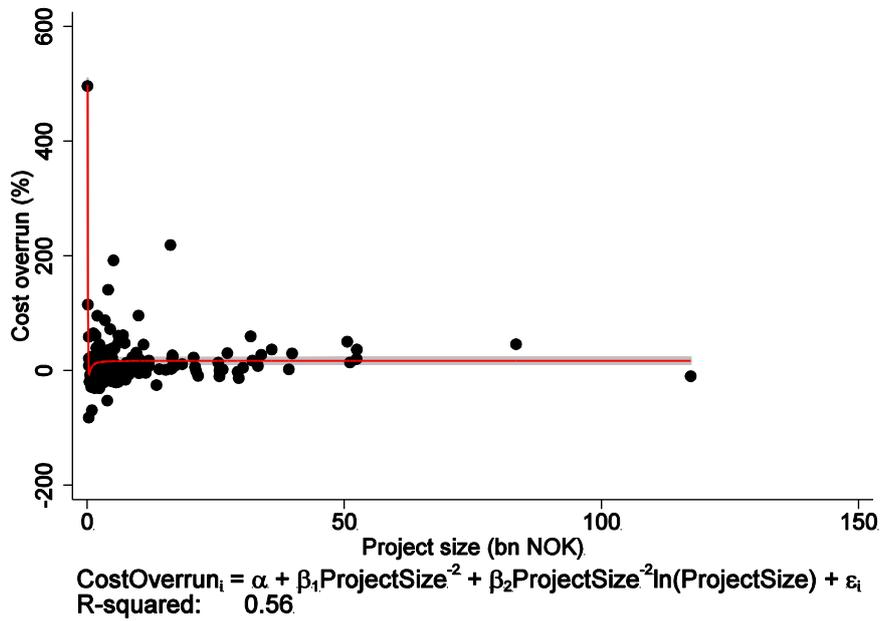


Figure shows fitted nonlinear relation between relative cost overruns (%) from offshore oil and gas development projects and project investment size (bn NOK) using a multivariable fractional polynomial model approach. The obtained model is specified through backward elimination.

Figure 3 shows a scatter plot between cost overruns and projects size and the fitted multivariable fractional polynomial model. The obtained nonlinear function is specified in Equation (3) and the regression results are reported in Table 2.

$$CostOverrun_i = \alpha + \beta_1 ProjectSize^{-2} + \beta_2 ProjectSize^{-2} \cdot \ln(ProjectSize) + \varepsilon_i \quad (3)$$

As seen, we have that the best trade-off between goodness of fit and model specification parsimony is a multivariable fractional polynomial model with two variables: $ProjectSize^{-2}$ and $ProjectSize^{-2} \ln(ProjectSize)$. Given the obtained functional form, the relation between cost overruns and project size is initially declining and convex. Thereafter, the regression line begins to increase albeit at a marginally declining rate. As such, the relation between cost overruns and project size moves through the whole spectre from negative to positive and finally to no relation. In short, the effect of project size appears to depend on the size of the project size.

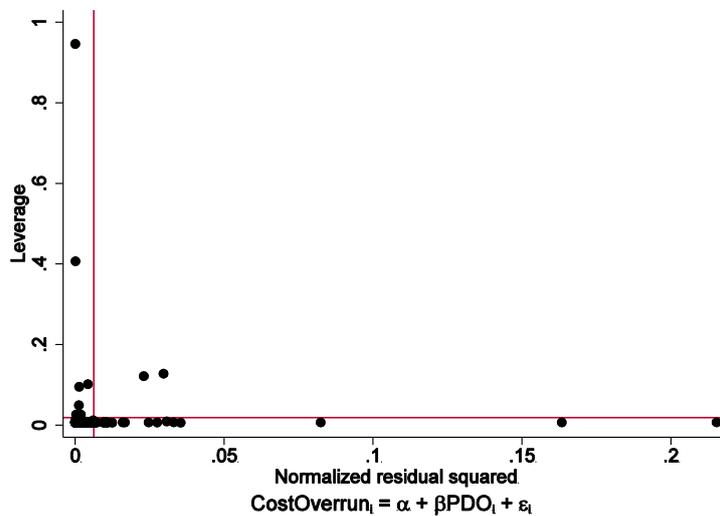
Table 2: Multivariable fractional polynomial

VARIABLES	Coefficient
$X^{-2} - 93.17: X = ProjectSize/100$	-0.004*** (0.000)
$X^{-2} \cdot \ln X + 211.23: X = ProjectSize/100$	-0.001*** (0.000)
Observations	160
R-squared	0.565

Robust p-value in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Results from the MFP modelling approach appear to coincide with results from the locally weighted regression, which is a good indication of the robustness. To further verify the robustness of the model we perform a misspecification test and an outlier analysis. First, through applying a link test (Pregibon, 1980), regressing cost overrun on the residual and squared residual of the MFP model, we find no evidence of misspecification of the model (p-value = 0.79). Second, by comparing the observations leverage (measured as deviations from the independent variables mean) against their squared residual we can gain insight to whether there are outlier observations impacting the regression results. As seen in Figure 4, only two observations fall within the upper left quadrant. The functional form of the MFP model is robust to dropping these outliers.

Figure 4: Analysis of outliers for mfp model



5.0 Discussion

To summarize, the results from both the locally weighted regression and multivariable fractional model fitting appear to conform with our ex ante expectations. The overall picture contains a negative sloped section, i.e., where increased project size reduces the problem of cost overruns, 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, for instance: diversification and complexity. First, regarding 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. Second, regarding 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 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 effect 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. However, the effect of complexity on cost overruns exhibits diminishing returns, which causes the schedule to become concave.

Further, 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.

6.0 Conclusion

This article addresses the inconsistencies found in the literature regarding the relation between cost overruns and project size. This is achieved by introducing a nonlinear model. As the literature finds both negative and positive relations as well as no significant relation, our nonlinear approach is able to reconcile these seemingly conflicting results by providing an overriding model in which other models become a special case. By utilizing offshore oil and gas development projects from the Norwegian Continental Shelf, we identify an initial declining relation between cost overruns and project investment size, where an increase in size decreases the tendencies of cost overrun. Further, the relation between these two variables changes such that an increase in size is associated with an increase in cost overruns. We find that these findings fit well the theory of diversification and complexity. The initial declining schedule can be explained through diversification, larger projects can be considered a portfolio of many small projects such that smaller projects possess more idiosyncratic risk. The increasing schedule can be explained by project size being a proxy for project complexity. As complex projects tend to be more difficult to estimate than simpler projects, complex projects should experience more cost overrun *ceteris paribus*.

References

- Beaton, Albert E., and John W. Tukey. "The fitting of power series, meaning polynomials, illustrated on band-spectroscopic data." *Technometrics* 16, no. 2 (1974): 147-185.
- Bertisen, Jasper, and Graham A. Davis. "Bias and error in mine project capital cost estimation." *The Engineering Economist* 53, no. 2 (2008): 118-139.
- Bland, J. Martin, and Douglas G. Altman. "Statistical methods for assessing agreement between two methods of clinical measurement." *The Lancet* 327, no. 8476 (1986): 307-310.
- Cleveland, W. S. 1979. Robust locally weighted regression and smoothing scatterplots. *Journal of the American Statistical Association* 74: 829–836.
- Cook, R. Dennis. "Detection of influential observation in linear regression." *Technometrics* 19, no. 1 (1977): 15-18.
- Creedy, Garry D. "Risk factors leading to cost overrun in the delivery of highway construction projects." (2006).
- Dahl, Roy Endré, Sindre Lorentzen, Atle Oglend, and Petter Osmundsen. "Pro-cyclical petroleum investments and cost overruns in Norway." *Energy Policy* 100 (2017): 68-78.
- Dantata, Nasiru A., Ali Touran, and Donald C. Schneck. "Trends in US rail transit project cost overrun." *Transportation Research Board* (2006).
- Flyvbjerg, Bent, Mette K. Skamris Holm, and Søren L. Buhl. "What causes cost overrun in transport infrastructure projects?." *Transport reviews* 24, no. 1 (2004): 3-18.
- Gray, Andrew R., Stephen G. MacDonell, and Martin J. Shepperd. "Factors systematically associated with errors in subjective estimates of software development effort: the stability of expert judgment." In *Software Metrics Symposium, 1999. Proceedings. Sixth International*, pp. 216-227. IEEE, 1999.
- Hamilton, L. C. 1991a. srd1: How robust is robust regression? *Stata Technical Bulletin* 2: 21–26. Reprinted in *Stata Technical Bulletin Reprints*, vol. 1, pp. 169–175. College Station, TX: Stata Press.

Hatton, Les. "How accurately do engineers predict software maintenance tasks?." *IEEE Computer* 40, no. 2 (2007): 64-69.

Heemstra, F. J., and R. J. Kusters. "Function point analysis: Evaluation of a software cost estimation model." *European Journal of Information Systems* 1, no. 4 (1991): 229-237.

Hill, J., L. C. Thomas, and D. E. Allen. "Experts' estimates of task durations in software development projects." *International journal of project management* 18, no. 1 (2000): 13-21.

Huber, Peter J. "Robust estimation of a location parameter." *The Annals of Mathematical Statistics* 35, no. 1 (1964): 73-101.

Jørgensen, Magne, Torleif Halkjelsvik, and Barbara Kitchenham. "How does project size affect cost estimation error? Statistical artifacts and methodological challenges." *International Journal of Project Management* 30, no. 7 (2012): 839-849.

Lawrence, I., and Kuei Lin. "A concordance correlation coefficient to evaluate reproducibility." *Biometrics* (1989): 255-268.

Lawrence, I., and Kuei Lin. "Assay validation using the concordance correlation coefficient." *Biometrics* (1992): 599-604.

Lorentzen, Sindre, and Petter Osmundsen. Cost performance on the Norwegian continental shelf. No. 6153. CESifo Working Paper, 2016.

Moløkken-Østvold, Kjetil, Magne Jørgensen, Sinan S. Tanilkan, Hans Gallis, Anette C. Lien, and S. W. Hove. "A survey on software estimation in the Norwegian industry." In *Software Metrics, 2004. Proceedings. 10th International Symposium on*, pp. 208-219. IEEE, 2004.

Norwegian Petroleum Directorate (2013). "Evaluation of projects implemented on the Norwegian shelf", Norwegian Petroleum Directorate.

NOU (1999). "NOU1999:11 Investeringsutvalget. Analyse av investeringsutviklingen på kontinentalsokkelen. (The investment commission. "Analysis of the investment development on the continental shelf")

Odeck, James. "Cost overruns in road construction—what are their sizes and determinants?." *Transport policy* 11, no. 1 (2004): 43-53.

Oljedirektoratet (2013), "Vurdering av gjennomførte prosjekter på norsk sokkel".

Pickrell, Don H. Urban rail transit projects: forecast versus actual ridership and costs. Final Report. No. PB-90-148693/XAB. Transportation Systems Center, Cambridge, MA (USA), 1989.

Riksrevisjonen (2001). "Dokument nr. 3:8 Riksrevisjonens undersøkelse av kostnadsoverskridelsene i feltutbyggingene Åsgard, Visund og Jotun".

Royston, Patrick, and Douglas G. Altman. "Regression using fractional polynomials of continuous covariates: parsimonious parametric modelling." *Applied statistics* (1994): 429-467.

Sauer, Chris, Andrew Gemino, and Blaize Horner Reich. "The impact of size and volatility on IT project performance." *Communications of the ACM* 50, no. 11 (2007): 79-84.

Sovacool, Benjamin K., Alex Gilbert, and Daniel Nugent. "Risk, innovation, electricity infrastructure and construction cost overruns: Testing six hypotheses." *Energy* 74 (2014): 906-917.

Van Oorschot, K. E., J. W. M. Bertrand, and Christel G. Rutte. "Field studies into the dynamics of product development tasks." *International Journal of Operations & Production Management* 25, no. 8 (2005): 720-739.

Yang, Da, Qing Wang, Mingshu Li, Ye Yang, Kai Ye, and Jing Du. "A survey on software cost estimation in the chinese software industry." In *Proceedings of the Second ACM-IEEE international symposium on Empirical software engineering and measurement*, pp. 253-262. ACM, 2008.

Øglend, Atle, Petter Osmundsen, and Sindre Lorentzen. "Cost Overrun at the Norwegian Continental Shelf: The Element of Surprise." (2016).