The Effect of Relationship Formation on Contract Duration and Performance in the Offshore Drilling Industry

Sorena Rahi[1] Mohammad Hossein Rahmati[1]

June 2017

Abstract

This paper is aimed at analyzing the effects of forming relationships between oil and gas companies and drilling rigs owned by drilling companies. For thus purpose, a panel data on 13240 contracts signed between 2000-2010 worldwide is used through employing a model with fixed effects and an instrumental variable for day-rates. Results show that repeated interaction between oil and gas companies and drilling rigs, does on one hand, increase the number of contracted projects in future contracts, and on the other hand, improves their drilling performance. Moreover, it is seen that the effects on the former are only captured by the first few interactions, and that they subside and vanish after the firms have contracted a couple of times. The effect on performance, however, remains consistent throughout the relationship.

[1]Sharif University of Technology

1 Introduction

Setting the right contract length is one of the challenges faced by firms in most bilateral contracts, specially if the object of the contract is in the form of a project that has to be carried out. In other words, the choice between short-term or long-term contracts is one of the most important aspects of contracting that both sides need to keep in mind. In the offshore drilling industry, oil and gas companies contract with drilling companies for their services. Such contracts, could span over multiple years and contain several projects within each contract. These projects are carried out in various locations within different regions worldwide. In order to determine the length of such contracts, the number of projects, as well as the riskiness of wells must be taken into account. Moreover, the specific characteristics of both sides, as well as market conditions play a significant role in setting the right duration.

In this paper, we look at another important factor affecting contract duration, and that is, the relationship formed among parties as a result of repeated contracting. When two parties sign multiple contracts, the problems of asymmetric information and adverse selection are expected to be resolved through a dissemination of information, as well as a formation of business familiarity among the employees of the firms. Moreover, it is also expected that the reputation gained by the agent leads to a resolution of moral hazard problems. Last but not least, business familiarity among employees of the firms is expected to speed up the projects through both challenging and routine situations, as these employees have gone through multiple projects together beforehand.

Throughout the literature on empirical contract theory, the effect of repeated interaction on contract duration has remained rather ambiguous, as has been its effect on contractual form. As is suggested throughout the literature, repeated contracting between parties on one hand, reduces the costs of contracting, and on the other hand, resolves moral hazard problems. The interplay between these two mechanisms has been shown to have an effect on the choice between fixed price or cost-plus contracts. We argue that the same mechanisms could also have an effect on the choice between short or long-term contracts as well.

Since many of the determinants of contractual form and duration are unobservable by the econometrician, identifying such effects becomes rather complicated. However, by trying to control several project, firm, and market characteristics, we aim to assess the effect of repeated interaction on both future contract length, as well as performance, in order to contribute to the literature with regards to such ambiguities, and to broaden the extant knowledge on this particular market.

In the offshore drilling industry, oil and gas companies that have previously leased tracks from governments, contract for the services of drilling companies for the purpose of either exploration or development of wells. Drilling companies drill on these tracks at designated locations using their drilling rigs. Prior to detailed contract negotiation, drilling companies are chosen by oil and gas companies through a bidding process for the price of their services. Further negotiations lead to the signing of contracts.

Depending on the location and characteristics of a project, there are various rigs operating worldwide. These rigs can be generally divided into two categories: shallow-water, and deep-water rigs. Shallow-water rigs rest on the ocean floor whilst drilling, and are usually found operating in waters with depths of less than 150 meters. The most abundant of such rigs is the Jack-up rig, which constitutes a significant share of rigs in the global market. The other category of rigs, deep-water rigs, contains those which are able to drill in deeper waters. Semi-submersibles and Drillships are the most prominent of this type.

As in many industries with similar structures, two contractual types are used in this industry, either turnkey or dayrate contracts. Turnkey contracts are reminiscent of fixed-price contracts used in procurement industries, while dayrate contracts are the counterpart of cost-plus contracts. In turnkey contracts, all costs are estimated prior to the signing of the contract, and thus a fixed price is paid for the commencement and completion of the entire contract. Conspicuously, such contracts require a detailed analysis of the project, and are costly. Yet, they can be used as a buffer against moral hazard concerns. Dayrate contracts on the other hand, are easier to write and less costly, in which a daily payment is agreed upon for the duration of the contract.

On average, a duration of 30-60 days is spent on each drilled well in a given project. However, contracts in this industry contain more than one project within each contract.

The aim of this paper is to assess the effect of repeated contracting among oil and gas companies and drilling rigs on contract duration and performance. More explicitly, we find the following effects to be present:

1. In the offshore drilling industry, the formation of relationships among oil and gas companies and individual drilling rigs, increases the duration of future contracts, as well as the *ex-ante* number of projects contracted upon in each contract.

2. In this market, repeated contracting among firms decreases the *ex-post* average days spent on drilling in future contracts, indicating and improvement in performance.

As mentioned, we focus on the relationship between oil and gas companies and individual rigs instead of drilling companies themselves. The reason behind this is that firstly, a rig's identity and that of its crew is of much more importance in a given region. Secondly, business familiarity among management is stronger at this level compared to that of a larger scale as these firms operate internationally and have multiple branches worldwide that at times act separately. Moreover, our robustness checks have also proven our contention that an operator-driller relationship seems to be ineffective, while an operator-rig relationship has a significant effect.

The literature related to the this paper lies within the broad category of empirical contract theory. More precisely, we look at three different lines of research related to our work. The first group of papers is those that assess the effect of changes in incentives on the principal-agent relationship, as well as its effects on contractual form. Such papers use firm or employee-level data in the process of a change in incentive structures in a firm, and compare the ex-post results with the predictions made by the theory. A key paper in this area is that of Lazear 2000. The author of this paper analyzes an auto glass company during a period in which the payment scheme is being changed from fixed wages to piece rates. It is shown that during the 19 months of gradual change, worker productivity increased by an average of 44 percent, half of which could be ascribed to incentive effects. A very important note made by the author is that not all industries shall show the same pattern of behavior, meaning that incentive effects must be assessed for each market as an individual case, for the underlying mechanisms to be identified. There have also been numerous papers published in this area, devoted to the assessment of incentive structures in various markets. Some papers have used experimental data (Lazear 2000, Shearer 2004), while others have used structural modeling to clarify their results (Paarsch and Shearer 1999, Haley 2003).

The second line of research that our paper draws from contains papers that assess the formation of implicit relationships among parties of a bilateral contract. Theoretical work in this area is based on Bull 1987 and MacLeod and Malcomson 1989. In an empirical work, McMillan and Woodruff 1999 show that in Vietnam, which was at the time known to have weak legal institutions, implicit relationships between firms and their suppliers had supplanted explicit, and legally enforceable arrangements. It is shown that for example, in situations where a firm has limited funds for a transaction, suppliers grant credits to the firm, and the amount of credit increases as the age of the relationship between them is increased.

In the offshore drilling industry, the same industry which our paper focuses on, Corts and Singh 2004 show that repeated contracting among operators and drilling companies in the Gulf of Mexico leads to more day-rate contracts being signed, compared to turnkey contracts. The authors' finding shows that in this market, and in the specific location being analyzed, formation of relationships among parties reduces moral hazard concerns more than it does contracting costs. In other words, as the authors put it, repeated interaction and day-rate contracts are substitutes in this market. In another paper, Kellogg 2011 analyzes the effect of repeated interaction on performance in the Texas onshore drilling industry, and by estimating a structural learning-by-doing model, shows that the formation of relationships between oil companies and individual drilling rigs reduces the time spent on drilling per drilled well. Other similar studies have also been conducted in various markets (Kalnins and Mayer 2004, Ryall and Sampson 2009, and Gil 2013).

The third group of papers related to our work contains those focused on the determinants of contract duration. The literature has been relatively sparse in this respect. A key paper worth noting is that of Joskow 1987. Based on Williamson 1983, which had theorized that relationship-specific investments reduce transaction costs, he uses data on contracts between electricity companies and their coal suppliers to show that three of such investment types, namely, site specificity, asset specificity, and dedicated assets, tend to increase the duration of contracts in this industry. He uses several fixed effects and dummy variables for the first two types of investment, and the contracted quantity for the latter, and demonstrates results that are robust to changes in both specification and estimation methods. Von Hirschhausen and Neumann 2008 find similar results in the international gas industry.

In this paper, our aim is to use the insight obtained through the literature to identify the effect of relationship formation on duration and performance, while controlling for other factors that are present, so that a direct mechanism could be identified for how implicit relationships can affect the outcome of contractual agreement. Section 2 presents our data, section 3 presents our empirical strategy, section 4 presents the results, and section 5 concludes.

2 Data

The data used in this paper was acquired from the RigLogix© database which provides comprehensive data on the offshore rig market, and includes technical and contractual specifications spanning over 20 years. We use the data points for contracts signed during the period 2000-2010 between operators and offshore drilling companies which provide drilling rigs and services. Our dataset contains details on contracts signed in multiple regions, and for different types of shallow-water and deep-water rigs worldwide. Table 1 provides descriptive statistics on the variables used in our work.

Table 2 provides the summary statistics for our dataset based on rig type, to demonstrate the obvious heterogeneity that exists between different types of rigs as they operate in various water depths and incorporate various degrees of risk. Table 3 provides the same statistics as Table 2 for different regions around the globe. It is observed that heterogeneity is present among variables for based on region. Moreover, table **??** provides the means and standard deviations of key variables used in our hypotheses, based on the number of interactions.

Table 1: Descriptive Statistics for Key Variables

Variable	Description
DayRate	Daily rental rate for the rig
TotalDaysK	Total Days on contract (Duration)
Drilling Projects	Number of Drilling Projects within contract
Average Drilling Days	Average days spent on drilling per number of drilling projects in a contract
Repeated Interactions(all)	Total No. of contracts signed between the Rig and Operator
Repeated Interactions(1y)	No. of contracts signed between the Rig and Operator within the last 365 days
NOC	A dummy variable which equates to 1 if Operator is a National Oil Company
Mean Location Water Depth	Average Water Depth for all project locations within the contract
Relative Scale (Projects)	The Relative Scale of Operator to Drilling Company based on Total No. of projects carried out Worldwide in the same quarter
Turnkey	A dummy variable which equates to 1 if the contract is Turnkey
Different Manager	A dummy variable which equates to 1 if the manager on board the rig is different from the owner of the rig
Age of Relationship	The age, in days, of the relationship between the Operator and Driller, counted from the first day the pair initiated their first contract

Table 2: Summary Statistics for Key Variable based on Rig Type

Rig Type	Contracts	Real Day Rate	TotalDaysK	Drilling Projects	Average Drilling Days
Jackup	7232	736.96	157.08	2.19	79.86
		(515.18)	(262.54)	(2.54)	(127.65)
Semisub	2849	1800.32	173.08	2.87	64.57
		(1378.71)	(247.34)	(3.51)	(70.01)
Other	2505	323.81	168.17	2.14	103.87
		(223.38)	(303.2)	(2.66)	(210.25)
Drillship	472	2574.17	245.59	3.05	89.09
		(1472.47)	(333.18)	(3.36)	(114.63)
Submersible	184	464.22	79.68	1.6	51.65
		(223)	(70.76)	(1.31)	(33.4)
All	13242	1045.67	164.7	2.36	80.02
		(1027.58)	(269.42)	(2.85)	(133.58)

Notes: Other includes Drill Barge, Inland Barge, Platform Rig, and Tender. All dayrates have been deflated using the United States CPI for 2010 in this table for demonstrative purposes. The regressions employ nominal values as time fixed effects have been used.

3 Model

In order to test our hypotheses we have developed the following fixed effects model:

$$Y_{ijt} = cons + \beta_1 Repeated_{it} + C'_{it}\beta_2 + \lambda_j + \mu_i + Time_t + \varepsilon_{ijt} \tag{1}$$

Where $Repeated_{it}$ is the number of repeated interactions between an oil company and an individual rig, C is the vector of all control variables, which includes project characteristics such as the average water depth of all

Table 3: Summary Statistics for Key Variable based on Region

Region	Contracts	Real Day Rate	TotalDaysK	Drilling Projects	Average Drilling Days
N. America - US GOM	7391	635.41	86.92	1.85	49.14
		(774.98)	(137.85)	(1.95)	(60.47)
Asia and Pacific	1706	1303.54	242	2.89	111.74
		(1011.39)	(316.64)	(3.38)	(173.96)
Europe	1630	1544.47	196.82	2.93	75.87
		(1205.08)	(245.04)	(3.27)	(88.99)
Africa	893	1617.35	223.67	2.43	118.39
		(1321.95)	(256.17)	(2.58)	(159.23)
Middle East	669	773.38	387.15	3.36	177.5
		(492.8)	(500.94)	(4.57)	(243.64)
S. America	560	1648.18	368.58	4.13	122.72
		(1337.8)	(463.11)	(4.95)	(186.36)
N. America - Other	391	1175.32	356.43	2.18	194.16
		(861.98)	(439.76)	(2.03)	(306.35)
Other	2	3421.32	108	2.5	42.08
		(1525.48)	(49.5)	(0.71)	(7.9)
All	13242	1045.67	164.7	2.36	80.02
		(1027.58)	(269.42)	(2.85)	(133.58)

Notes: Europe includes North Sea, Eastern Europe, and Mediterranean. Asia and Pacific includes the Caspian sea, far east Asia, south Asia, Southeast Asia, the Black Sea, and Australia. Africa includes west Africa and Other. Middle East includes the Persian Gulf, and the Red Sea. N. America - Other includes the Canadian Atlantic, Alaska, Mexico, and Other. South America includes Brazil, Caribbean, and Venezuela. All dayrates have been deflated using the United States CPI for 2010 in this table for demonstrative purposes. The regressions employ nominal values as time fixed effects have been used.

projects carried out within a contract, relative scale, turnkey, different manager, among other variables. λ_j represents region fixed effects, which is expected to control for the general characteristics of a region such as the types of fields as well as site specific investments. μ_i represents rig fixed effects which control for specific rig characteristics such as its age, quality, as well as asset specific investments. $Time_t$ represents time fixed effects which control for time-variant phenomena such as variations in oil prices as well as other external shocks. Moreover, all regressions shall be clustered on rigs in order to allow for serial correlation between the error terms of rigs. The dependent variables used are on one hand, the number of contracted projects and duration, and on the other hand, the average days spent on drilling.

A more sophisticated model is also defined as follows to capture the variations that occur within regions across time:

$$Y_{it} = cons + \beta_1 Repeated_{it} + C'\beta_2 + \lambda_i + \mu_i + Time_t + \lambda_i \times Time_t + \varepsilon_{it} \quad (2)$$

In this model, $\lambda_i \times Time_t$ represents the interactions between the region and time fixed effects to control for the different trends that exist among different regions through time. Moreover, day-rates (or their turnkey counterparts, divided by the number of days) are controlled for as a measure of price in this industry, representing a substantial amount of information in a contract. However, to deal with the endogeneity concern that arises from using day-rates, day-rates have been instrumented with the average day-rates of other firms in the given quarter.

Table 4: Summary Statistics for Key Hypothesized Variables based on the Number of Repeated Interactions

Repeated Contracts(1y)	TotalDaysK	Drilling Projects	Average Drilling Days
0	161.71	2.21	82.86
	(285.41)	(2.77)	(149.36)
1	164.37	2.31	76.35
	(280)	(2.76)	(118.49)
2	179.1	2.61	78.23
	(254.04)	(3.08)	(107.49)
3	173.3	2.51	81.87
	(232.28)	(2.95)	(123.56)
4	189.86	2.57	93.8
	(260.37)	(2.54)	(159.36)
5	163.14	2.58	80.3
	(203.09)	(2.67)	(116.48)
6	154.55	2.72	70.9
	(195.06)	(2.95)	(97.18)
7	142.94	2.5	68.31
	(167.57)	(2.64)	(84.73)
8	135.68	3.08	56.31
	(163.94)	(4.27)	(52.91)
9	142.88	2.97	62.26
	(149.43)	(3.26)	(50.36)
10+	146.16	3.32	53.67
	(210.91)	(3.66)	(57.16)

Notes: This table represents summary statistics only for the first nine repeated interactions, as well as for those greater or equal to ten.

4 Results

In this section we shall present the results of our analysis. Table 4 presents baseline results for the three variables in our contentions. As seen, the baseline model fails to reject our hypothesis. Through the formation of relationships between oil and gas companies as project operators and individual drilling rigs, future number of projects, as well as contract duration increase significantly. If we consider only the recent number of interactions in the previous year, we also observe an improvement in performance as average days spent on drilling falls. Since in other papers such as Kellogg 2011, due to considering an effect for forgetfulness, no weight is given to contracts that were signed prior to a specific period before the singing of the current contract. Therefore, the results in columns 4 through 6 are more dependable.

It could thus be said that formation of relationships among parties in the offshore drilling industry on one hand, increases the number of projects on average by approximately 0.1 per interaction, and duration is increased by over 3 days. Also, the average days spend on drilling falls by over 0.5 days on average per interaction. It should be noted that the exact amount of changes varies among regions and rigs, and the magnitude of the fixed effects must be taken into account in order to derive the exact effect for each rig, or for any region in a given month. Note that the effect on duration is the culminated effect from the increase in project numbers, as well as the fall in drilling days. It appears that the former is stronger and that duration increases.

There are also several facts that could be of interest, and are derived from table 4. First of all, the coefficients for NOC in our regressions imply that contracts signed with national oil companies are on average longer in

Table 5: Baseline Model

Variables	(1) TotalDaysK	(2) Drilling Projects	(3) Average Drilling Days	(4) TotalDaysK	(5) Drilling Projects	(6) Average Drilling Days
Repeated Interactions(all)	3.847***	0.0963***	-0.367			
	(0.917)	(0.0176)	(0.242)			
Repeated Interactions(1y)				3.275***	0.0994***	-0.553**
				(0.992)	(0.0187)	(0.253)
Mean Location Water Depth	0.0136***	0.000176***	0.00143*	0.0134***	0.000169***	0.00146*
	(0.00284)	(4.16e-05)	(0.000852)	(0.00285)	(4.18e-05)	(0.000851)
Relative Scale	-1.698	-0.0480***	2.193**	-1.698	-0.0483***	2.195**
	(1.224)	(0.00990)	(0.981)	(1.223)	(0.00990)	(0.980)
NOC	92.58***	0.441*	15.61***	92.77***	0.448*	15.58***
	(22.07)	(0.255)	(5.712)	(22.10)	(0.257)	(5.707)
Different Manager	-44.92***	-0.112	-10.57**	-44.16***	-0.103	-10.47**
	(13.71)	(0.206)	(5.215)	(13.64)	(0.207)	(5.186)
Turnkey	-27.59***	-0.566***	-0.486	-27.80***	-0.562***	-0.580
	(8.502)	(0.130)	(2.735)	(8.470)	(0.129)	(2.735)
Age of Relationship	0.00115	-3.38e-05	-0.000420	0.00309	-1.11e-06	-0.000396
	(0.00366)	(6.09e-05)	(0.00135)	(0.00351)	(5.93e-05)	(0.00131)
Constant	265.9***	3.693***	95.03***	267.2***	3.739***	94.70***
	(54.58)	(1.236)	(25.87)	(55.07)	(1.250)	(25.86)
Observations	7,629	7,104	7,104	7,629	7,104	7,104
Number of Rigs	724	684	684	724	684	684
Rig Fixed Effect	Y	Y	Y	Y	Y	Y
Region Fixed Effect	Y	Y	Y	Y	Y	Y
Time Fixed Effect	Y	Y	Y	Y	Y	Y
Time-Region Fixed Effect	N	N	N	N	N	N

Robust standard errors in parentheses. All regressions are clustered on rigs
*** p<0.01, ** p<0.05, * p<0.1

duration, yet more days are spent on drilling, indicating poor performance. On the other hand, the coefficient on Different Manager implies that in contracts where a third party firm acts as the project manager on the rig, projects tend to be shorter in duration, yet stronger performance is exerted in them. Also, turnkey contracts tend to be shorter in duration, as expected.

Table 4 presents results for our complicated model that includes Time-Region fixed effects, as well as day-rates as a control variables, instrumented with the average day-rate of other firms in the same quarter. Columns 1 through 3 show results with only the added new fixed effects, while columns 4 through 6 include both the new fixed effects, and the control for day-rates. Results indicate that our model is robust to imposing heavier restrictions that better control for regional variations in time. Moreover, day-rates, as the market price in this industry, contain a plethora of information that is, otherwise, unobservable by the econometrician. By applying our instrumentation strategy, we have avoided the risk of them being endogenous in our model by becoming correlated with the error terms, yet we have been able to control for the information contained in them. Controlling for both day-rates and regional variations in time has not changed the significance of the coefficients for our target variables, yet it has changed their magnitudes. Compared to the baseline results, the increase in duration has halved, while the decrease in drilling days has doubled. The increase in the number of projects has also been lowered compared to the previous results. It should again be stressed that the eventual change in duration is itself affected by both the change in the number of projects, as well as the change in performance.

Table 6: Extended Model Considering Different Trends for Each Region, and Day-Rates

Variables	(1) TotalDaysK	(2) Drilling Projects	(3) Average Drilling Days	(4) TotalDaysK	(5) Drilling Projects	(6) Average Drilling Days
Repeated Interactions(1y)	1.532*	0.0665***	-1.024***	1.488*	0.0658***	-1.032***
	(0.889)	(0.0155)	(0.288)	(0.874)	(0.0154)	(0.288)
Day-Rate				0.000182*	1.76e-06	2.07e-05
				(9.61e-05)	(1.46e-06)	(2.43e-05)
Mean Location Water Depth	0.00737**	7.78e-05*	0.000208	0.00613**	6.52e-05	5.90e-05
	(0.00301)	(4.61e-05)	(0.000964)	(0.00290)	(4.86e-05)	(0.00101)
Relative Scale	-0.887	-0.0416***	1.368**	-0.796	-0.0407***	1.378**
	(0.835)	(0.0113)	(0.643)	(0.818)	(0.0112)	(0.643)
NOC	99.95***	0.354	27.34***	100.1***	0.358	27.39***
	(30.50)	(0.359)	(8.170)	(31.03)	(0.363)	(8.214)
Different Manager	-7.530	0.195	-0.817	-12.60	0.146	-1.384
	(12.33)	(0.234)	(5.194)	(12.34)	(0.234)	(5.139)
Turnkey	-18.81**	-0.493***	1.458	-18.78**	-0.491***	1.470
	(7.308)	(0.135)	(3.016)	(7.410)	(0.136)	(3.020)
Age of Relationship	0.00622**	1.90e-05	0.00109	0.00548*	1.27e-05	0.00102
	(0.00310)	(5.50e-05)	(0.00128)	(0.00302)	(5.56e-05)	(0.00127)
Constant	1,100***	6.780**	420.4***	1,091***	6.709**	418.8***
	(191.4)	(2.685)	(46.72)	(192.8)	(2.692)	(46.64)
Observations	6,224	6,003	6,003	6,224	6,003	6,003
Number of Rigs	598	582	582	598	582	582
Rig Fixed Effect	Y	Y	Y	Y	Y	Y
Region Fixed Effect	Y	Y	Y	Y	Y	Y
Time Fixed Effect	Y	Y	Y	Y	Y	Y
Time-Region Fixed Effect	Y	Y	Y	Y	Y	Y

Robust standard errors in parentheses. All regressions are clustered on rigs.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

We have presented it separately in our models in order to identify the overall effect, and its direction.

Although we were able to provide consistent results towards the analysis of our contention, a key question arises: How does the number of interactions matter in determining the above identified effect? In other words, are the first few interactions between parties as effective as the later encounters? or does the effect dissipate as time goes by?

To answer these questions, we estimated our baseline model including day-rates, but we have replaced our target variable with each individual number of interactions among parties. Results for this specification are demonstrated in table 4.

As is seen from the results, contract duration and the number of projects are only affected by the first few interactions, and the very long-term higher interactions of 10 and above, while performance is shown to be affected gradually through time. Also note that interactions of 10 or above are not that common within our sample, and could be indicative of outliers. One could speculate that the reason why the effect of repeated interaction dissipates for the first two variables is that there exists an imposed upper limit on how many drilling projects could exist within a given project, which is determined by the limitations arising from the leased track itself. However, the positive effect on performance is seen to be always and gradually improving as a results of a resolution in moral hazard concerns and business familiarity. Both models, both with and without the control for day-rates consistently corroborate these findings.

5 Conclusion

In this paper, we aimed at the assessment of how the formation of relationships among lease operators and drilling rigs affects *ex-ante* and *ex-post* concerns in their bilateral contractual agreements. To this end, we used a panel dataset containing 13240 data points for contracts signed between 2000-2010 worldwide. We then estimated several fixed effects models.

In the baseline model, we included region, time, and rig fixed effects to control for heterogeneity and relationship specific investments. We also used several project and market characteristics to control for project risks, and specific conditions unique to each contract. Results showed that relationship formation on one hand, increases contract duration and the number of projects signed within each contract as the relationship becomes stronger, and on the other hand, performance is improved as well.

For robustness, Time-Region fixed effects were included in the extended model to control for regional variations in time. Moreover, day-rates were also controlled for as a proxy for a wide range of inside information that is available to both sides, yet unobservable by the econometrician. The average day-rates of other contracts in the same quarter were used as an instrumental variable to resolve endogeneity concerns. Results of the extended model lay support to our claims, and affirm the results found in the baseline model.

In order to find out whether all interactions are effective, or just the earlier ones, our baseline model was estimated again by replacing the general variable for repeated interaction with variables fo each individual interactions up to the first 9 interactions, as well as one variable indicating interactions of 10 and above, as these are low occurrences. We have shown that contract duration and drilling projects are only affected by the first few interactions, with the positive effect subsiding over time, while performance keeps improving in a gradual manner.

Table 7: Extended Model Considering Different Trends for Each Region, and Day-Rates

Variables	(1) TotalDaysK	(2) Drilling Projects	(3) Average Drilling Days	(4) TotalDaysK	(5) Drilling Projects	(6) Average Drilling Days
1 Interaction	-1.848	0.121*	-6.497***	-1.087	0.127*	-6.359***
	(4.855)	(0.0706)	(1.650)	(4.830)	(0.0702)	(1.634)
2 Interactions	20.13***	0.525***	-9.780***	20.22***	0.527***	-9.738***
	(7.167)	(0.120)	(2.540)	(7.129)	(0.120)	(2.531)
3 Interactions	21.09**	0.471***	-4.546*	21.12**	0.473***	-4.505*
	(8.320)	(0.148)	(2.341)	(8.304)	(0.148)	(2.339)
4 Interactions	30.99***	0.543***	-0.926	31.26***	0.546***	-0.873
	(11.80)	(0.153)	(3.960)	(11.82)	(0.154)	(3.948)
5 Interactions	4.813	0.529**	-8.026**	5.405	0.534***	-7.918**
	(10.94)	(0.207)	(3.900)	(10.85)	(0.206)	(3.893)
6 Interactions	-12.46	0.339	-13.83***	-11.50	0.348	-13.65***
	(12.39)	(0.228)	(4.020)	(12.53)	(0.228)	(4.009)
7 Interactions	8.302	0.235	-4.944	9.079	0.243	-4.781
	(13.85)	(0.225)	(4.214)	(13.97)	(0.227)	(4.213)
8 Interactions	-28.70**	0.147	-15.76***	-28.82**	0.148	-15.73***
	(14.40)	(0.233)	(4.480)	(14.16)	(0.232)	(4.449)
9 Interactions	-0.818	0.368	-3.694	-0.155	0.375	-3.541
	(18.20)	(0.428)	(6.243)	(18.37)	(0.429)	(6.260)
10+ Interactions	30.64*	1.373***	-13.28***	29.82*	1.360***	-13.52***
	(17.89)	(0.298)	(3.935)	(17.07)	(0.293)	(3.868)
Day-Rate				0.000217***	1.78e-06	3.62e-05**
				(6.29e-05)	(1.18e-06)	(1.84e-05)
Mean Location Water Depth	0.0132***	0.000180***	0.00111	0.0113***	0.000164***	0.000786
	(0.00295)	(4.57e-05)	(0.000843)	(0.00300)	(4.83e-05)	(0.000864)
Relative Scale	-1.325	-0.0490***	1.651*	-1.098	-0.0473***	1.686*
	(1.064)	(0.0119)	(0.941)	(1.043)	(0.0114)	(0.940)
NOC	85.83***	0.243	18.69***	87.18***	0.253	18.90***
	(25.30)	(0.299)	(7.130)	(25.64)	(0.303)	(7.113)
Different Manager	-43.87***	-0.0401	-9.357**	-54.95***	-0.129	-11.16**
	(12.89)	(0.233)	(4.672)	(13.76)	(0.246)	(4.978)
Turnkey	-25.54***	-0.541***	-0.316	-25.83***	-0.540***	-0.297
	(7.966)	(0.132)	(2.773)	(8.382)	(0.135)	(2.812)
Age of Relationship	0.00599*	-1.68e-06	0.00108	0.00558	-4.40e-06	0.00103
	(0.00346)	(6.11e-05)	(0.00129)	(0.00347)	(6.16e-05)	(0.00129)
Constant	621.5***	8.680***	92.54**	603.8***	8.540***	89.69**
	(171.8)	(2.717)	(37.16)	(174.1)	(2.739)	(37.10)
Observations	6,224	6,003	6,003	6,224	6,003	6,003
Number of Rigs	598	582	582	598	582	582
Rig Fixed Effect	Y	Y	Y	Y	Y	Y
Region Fixed Effect	Y	Y	Y	Y	Y	Y
Time Fixed Effect	Y	Y	Y	Y	Y	Y
Time-Region Fixed Effect	N	N	N	N	N	N

Robust standard errors in parentheses. All regressions are clustered on rigs. The maximum value for interactions above ten is 26.
*** p<0.01, ** p<0.05, * p<0.1