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Does institutional quality matter for offshore supply rates?

An empricial analysis of the relationship between costs and institutional quality, as evidenced by day rates in the PSV market 1995-2013

Anne Margrethe Vik

Supervisor: Torfinn Harding

Master Thesis in Economics

NORWEGIAN SCHOOL OF ECONOMICS

"If applied econometrics were easy, theorists would do it. (...) Carefully applied to coherent causal questions, regression and 2SLS will almost make sense. Your standard errors probably won't be quite right, but they rarely are."

Angrist & Pischke, *Mostly Harmless Econometrics* (2009)

Abstract

The role of institutions for long-run economic development is widely recognized as important. However, we have limited knowledge about how institutional quality systematically influence prices in a specific market. This thesis investigates the relationship between a country's institutional quality and day rates in the global offshore supply vessel market. Two hypotheses constitutes the starting point for investigating this relationship. One, there are arguments suggesting a negative association between institutional quality and costs, i.e. higher costs in countries with low quality institutions due to higher operational risk. Two, at the same time there are arguments suggesting a positive effect, i.e. higher costs in countries with high institutional quality, because these countries in general are more expensive.

Using proprietary offshore market data, I find that there is a positive correlation between a country's institutional quality score and earned day rates. Furthermore, I investigate through what channels this correlation works. I find that institutions influence day rates through the positive correlation between institutions and economic development. Because of the presence of competition across countries, we would expect costs and prices to become equal across countries. However, it seems that prices of offshore services may be higher in richer countries due to the substantial presence of non-tradables. Lastly, I follow Acemoglu and Johnson (2005) in their unbundling of institutions. By using proxies for property rights institutions and contracting institutions, I find that institutional quality matter in the form of property rights institutions, and that the latter has no influence on day rates. The thesis also offers qualitative discussion of the results.

Preface

This thesis is the last step to complete my Master of Science in Economics at the Norwegian School of Economics (NHH), and my CEMS Master in International Management.

Throughout my years as student at the Norwegian School of Economics, I have developed an interest in offshore-related industries. Both because of its global nature, and also a very hands-on, operational business. I have worked part-time in an offshore company based in Trondheim, and taken shipping-related courses at NHH.

How a fundamental establishment such as institutions influence countries' current economic situation is fascinating. The offshore energy industry is global, and thus exposed to various degrees of institutional quality. Having worked with a company where country-specific rules and regulations play an important role for operation and profit, I wanted to investigate whether prices in a global business such as the offshore supply vessel industry are influenced by differences in the quality of institutions.

The process of writing this thesis has put to test my analytical skills and at the same time improved my understanding of econometrics. The process has been challenging, but a steep learning curve also has its benefits.

I would like to thank my supervisor Torfinn Harding for his time and good answers to all my questions throughout the writing process. I also would like to thank BOA Offshore AS in Trondheim for access to valuable offshore market and supply vessel data. Furthermore, I would like to thank DOF ASA, represented by Chartering Manager Kristian Vea, Charterer Anita Olaisen and Crewing Manager Atle Fagerbakke for providing useful information about the supply vessel market is practice. Lastly, I would like to thank Henning Mostue from Sparebank1 Markets for valuable input to the discussion of the main findings.

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1. Introduction

1.1 Motivation

Norway is a country with long traditions for seagoing trade and industry. With the discovery of oil in the 1970's, new market needs and opportunities were created. From this emerged the offshore service sector. In Norway alone, the offshore service and supply industry currently consists of more than 1250 companies across the entire value chain: From seismic and drilling rig equipment, through valves, nuts and hoses for the shipyard industry, to subsea technology and advanced offshore supply and service vessels (Government.no, 2014).

I got the opportunity to work with one of these companies during the summers of 2013 and 2014. I quickly understood that this is a sector where market players need to adjust rapidly to changing business environments, dependent on where in the world your vessels operate. Different rules and regulations from country to country, in addition to the hitches that come with operating remotely in countries far away from home constitute a number of challenges for shipowners[1]. On top of this, operators need to take into account changes in the global energy market, as the main task of offshore supply is to support offshore oil and gas installations.

The Norwegian Daily, "Dagens Næringsliv", wrote on Feb 14 2015 about Norwegian shipowners' struggles in Brazil. There, every fourth offshore service vessel belongs to a Norwegian shipowner (Langved, Segrov, & Ånestad, 2015). The Brazilian state-owned energy company and monopolist Petrobras' unpredictable behavior and corruption scandals, accompanied by slow bureaucratic processes, makes life hard for participants in the offshore service market. Do factors like these, as caused by differences in institutional quality, have significant impact on offshore market prices over time?

The political procedures and enforcement of rules depend on a country's institutional framework. Institutional quality is a much-discussed topic in the field of Economics. Focus often is on the role of institutions in economic growth and development. There is broad

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[1] I consequently use "shipowner" instead of "ship owner" to improve readability.

consensus that good institutions form a necessary foundation for long-term economic growth. Economic institutions determine the constraints on and the incentives to investment, which again shape economic outcomes (Acemoglu et al., 2005).

The offshore service sector is global of nature, being part of the upstream oil and gas logistics chain. The location of Planet Earth's oil and gas reservoirs was established before the term "institutions" was introduced. The more or less random distribution of oil and gas activity around the world results in the offshore service sector being subject to a diversified selection of legislatures.

No study has so far attempted to look at the connection between offshore market day rates and institutional quality. My current perception is that studies are concerned with identifying short-term factors that affect market activity, and thus overlook long-term, country-specific fundamentals such as institutions. The offshore supply vessel market is a market in constant development, where analysts seem more interested in looking into the crystal ball than analyzing cost drivers by looking at historical data. As a global industry that operates in countries in both ends of the institutional quality range, it is interesting to see if differences between countries play a significant part in cost levels.

This thesis aims to find whether a relationship exists between a country's institutional quality and day rates in the offshore supply vessel market for the vessels operating under the legislature of the country in question. I approach the problem by building a model where identifying this relationship is in focus. The model is not supposed to be predictive. Furthermore, I take a closer look at which channels institutional quality may influence day rates through, by using proxies for a country's wealth, property rights institutions and contracting institutions. I use limited-access offshore market data in my research, combined with data from various other established data sources. The study also offers a qualitative discussion of the results.

Two alternative hypotheses emerged when I first started looking into the topic of day rates. One, consider a country with low quality institutions. Would the shipowners require a risk premium when operating in these countries, and would this together with other factors such as difficult logistics and slow communication result in a negative correlation between day rates and institutional quality? Two, are countries with good institutions richer, and would the general higher real price levels in these countries this lead to a positive correlation? With that in mind, the following question represents the baseline issue that I will answer empirically:

Does a country's institutional quality score matter for day rates in the platform supply vessel market?

Access to high quality market data inspired me to take a closer look at how institutional quality systematically influence prices in a global, competitive market.

1.2 Literature review

In this section, I will describe previous research made on the subject and related subjects. This puts the thesis into perspective, and describes how my research might add new information to existing literature.

For the topic of institutional quality, there is a vast amount of research made on the subject. A regular approach is whether institutions influence countries' economic performance, and in which direction the causality points. Several research papers have sought to answer the question of how institutions in. By exploiting differences in European mortality rates as an instrument for current institutions, Acemoglu, Johnson, & Robinson (2000) estimate large effects of institutions on income per capita. There is broad consensus that quality of institutions is a fundamental determinant for economic development. In the article "Institutions as fundamental cause of long-run growth", Acemoglu et al. (2005) highlight this issue. They find that factors such as constraints on and incentives for investments, shaped by economic institutions, are fundamental for economic outcome.

A much-cited definition of institutions is that "institutions are the rules of the game in a society" (North, 1990). The growing consensus among economists and political scientists is that the institutions of a society, i.e. a society's social, legal and political organization is important for economic performance (Acemoglu & Johnson, 2005).

Different types of institutions have unequal effects on economic performance. Acemoglu & Johnson (2005) evaluates the importance of "property rights institutions", which protect citizens against expropriation by the government and powerful elites, and "contracting institutions", which enable private contracts between citizens. In the article, the authors find that "property rights institutions have first-order effects on long-run economic growth, investment, and financial development" when using average expropriation risk as proxy. On the other hand, contracting institutions appear to matter only for the form of "financial intermediation".

There are arguments suggesting both a positive and negative relationship between institutional quality and costs. Below, I will discuss these arguments as they appear in literature.

Bohn & Deacon (2000) take a closer look at the effect of property rights and extraction of natural resources. They seek to answer the question of how important, quantitatively, weak property rights are the use of natural resources. They find that greater ownership risk can lead to slower exploitation of some resources[2]. Oil exploration is an example of this. Because it requires heavy upfront investments, investors are not willing to take the risk if property rights are weak. Their study offers a link to the effect of property rights on other capital intensive industries. It also suggests that costs are higher in countries with low institutional quality, which points in the direction of a negative relationship between institutional quality and day rates in the supply vessel market. Day rates would be higher, reflecting an incorporated risk premium.

The quality of institutions have direct influence on company-level decision-making as well. Institutional quality does matter to energy companies when deciding where to drill for oil and gas. When opportunities are divided by national borders, investors choose to drill on the side with better institutional quality two out of three times (Harding & Cust, 2014). This too points in the direction higher day rates in countries with low quality institutions.

Speculatively, operating costs may be higher in countries with low institutional quality because this implies "bad environment", e.g. lack of infrastructure, communication issues and other things.

A recently published master thesis from the Norwegian School of Economics makes a qualitative comparison of the Brazilian and Norwegian offshore supply vessel markets, and concludes that both operating and capital expenditure are substantially higher in Brazil than in

[2] Their findings are ambiguous, i.e. the effect of property rights is dependent on type of natural resource.

Norway. Again, their findings speaks in favor of higher costs in countries with lower institutional quality. Higher crew costs and the Brazilian state-owned company Petrobras being a challenging client are identified as main drivers of higher operating costs (Vikenes & Johannessen, 2014). Wage levels as drivers for operating costs is something I will use when I investigate further what channels institutional quality influence offshore market rates[3].

On the other hand, there are arguments for a positive effect between quality of institutions and costs. Another recently published master thesis investigate which factors influence day rates in the Northwest Europe offshore rig market. The rig market is closely related to the offshore supply vessel market. Operating in Norwegian waters requires a special license. They conclude that rigs that are approved for operating in Norwegian waters obtain a day rate premium of 30% (Nygård & Simonsen, 2014). This indicates that high quality institutions drive costs upwards. I will use the same source of offshore market data. However, for reasons explained later, I structure the data differently and use different econometric techniques.

Institutional quality is often associated with level of democracy. Acemoglu et al. (2005) investigates the relationship between income and democracy. They find that the effect of income on democracy is not causal, but that among other things, the positive correlation between income and democracy is due to historical events that affect the economic and political "development path" of a society. This leads to persistent influences on economic and political outcomes. In other words, historical events that lead to the development of democratic institutions, which again is a foundation for economic development.

How to measure democracy is not straightforward. One of the most famous measures is Freedom House's "Freedom of the World" index, where each country's score is based on two numerical ratings for political rights and civil liberties (Freedom House, 2015). The Polity IV project provides another measure, widely used in academic research (The Polity Project, 2015). The World Bank's World Development Indicators is another well-known resource for institutional quality research.

[3] The two conclusions might seem contradictory. One thesis states that Norway is the more expensive country due to special local requirements, while the other points to Brazil being more expensive for what seems like similar reasons. However, the first looks at rig market rates compared to the rest of the Northwest Europe region, while the other only compares Brazil to Norway. A comparison of rig rates between Brazil and Norway would have given a more comparable conclusion in this sense.

Overall, institutions are proved to have importance for a country's economic development. Good property rights institutions creates incentives to invest, and defines economic growth trajectories. A consequence of the energy sector being global, the exploration and extraction of oil is subject to various legislatures and policies. The quality of institutions is empirically proved to matter for where market players choose to drill for oil, and to what extent investors choose to invest in oil exploration. However, no one has so far investigated the relationship between institutional quality and day rates in the offshore supply vessel market, which is closely related to the oil industry.

What makes this segment of the offshore industry interesting is that vessels follow the oil industry all around the world. Thus, operations are exposed to very different environments of institutions. Additionally, the presence of global competition would lead us to expect that prices and costs become similar across countries, or alternatively differ to the extent of input being non-tradable. This makes the offshore supply vessel industry very interesting for analyzing differences in costs.

Despite the fact that the offshore supply industry is subject to different rules and regulations dependent on what country the operations take place, the issue has not been empirically tested. This thesis examines whether the quality institutions influence prices in a specific, competitive and global industry, by using offshore market data across the period 1995-2013.

1.3 Outline

In section 1, I describe the overall motivation behind the research question. The section contains information about background and literature, and puts the thesis in the context of current economics. Section 2 is a description of the offshore supply vessel market. The section gives the reader a necessary overview of the global market, and a foundation for understanding how the concept of day rates and related cost drivers. Research methodology and applied econometric techniques are explained in section 3. A description of data sources and pre-analysis data treatment is found in section 4. In section 5, the baseline results are presented and discussed. Section 6 is an extension of section 5, and further investigates the reasons behind the baseline results. Lastly, section 7 provides a conclusion, together with a discussion of limitations and suggestions for further research.

2. Market description

In this section, I will describe the global supply vessel market, and discuss topics such as vessel properties, operational procedures and cost drivers. The purpose is to help the reader to put the main findings in context, by describing the reality backdrop of this thesis.

2.1 The global supply vessel market

2.1.1 Vessel categories

There are two main categories of supply vessels, namely the Platform Supply Vessel (PSV) and the Anchor Handling Tug Supply (AHTS) vessel[4]. The abbreviation OSV – Offshore Supply Vessel – is commonly used as designation for all types of supply vessels, where PSV and AHTS are the two biggest categories. Where the PSVs' main task is supply of different sorts of equipment to and from offshore installations, the AHTS is a specially designed vessel for anchor handling and towing offshore platforms, barges and production modules/vessels (Farstad, 2012). PSVs are less specialized and a more generic type of vessel compared to the AHTS. Overall, running a PSV is cheaper than its more complex sister, the AHTS (Vea, 2015).

I limit the scope of offshore supply vessels to PSVs only. In the specified model, I seek to compare as equal vessels as possible by eliminating time-invariant individual properties. This is best done with the use of econometric techniques, and will be further explained later.

A PSV is often categorized by its deadweight tonnage (DWT), which describes how much the vessel can safely carry. The categories used are 1,000-1,999 DWT, 2,000-2,999 DWT, 3,000-3,999 DWT and 4,000+ DWT. Other PSV specifications are clear deck area (300 – 1200 m^2) and sophistication of dynamic positioning system[5].

Each vessel receives a unique number upon launching, referred to as the IMO number. This number is made of the three letters "IMO" followed by a seven-digit number assigned to all

[4] I will use all "boat", "ship" and "vessel" as words for describing the object of interest, namely the platform supply vessel. "Shipowner" refers to an owner of such vessels, i.e. the receiver of the day rate. A "charterer" is the company who hires the vessel.

[5] Dynamic position system (DP) is a computer controlled system that automatically maintain a ship's position.

individual ships by IHS Maritime. This number is never changed, independent of changes to the ship such as flag or reconstruction (IHS Global Limited, 2015).

2.1.2 The supply vessel market in context

OSVs take part in all phases of oil and gas field exploration and production, and is a key part of the "upstream logistics" chain. The market for offshore supply vessels (OSV) is closely related to activity in the oil sector around the world. Higher activity in the oil and gas sector implies higher demand for offshore supply services. Oil companies hire supply vessels dependent on field operational needs. These vary greatly – long-term production assistance require long-term dedication, while drilling support require only short-term assistance.

There are two types of contracts, namely *spot* and *term*. Spot contracts can last from 1 day up to 29 days, while term contracts are everything from 30 days and above and can last for years (Ådland, 2013).

The supply curve is relatively inelastic in the short term. It usually takes 2-3 years to build a vessel. The demand curve is also quite inelastic, as the oil companies depend on getting supplies to their platforms. To keep the production running, the rig owners are completely dependent on deliveries of equipment, personnel and so on.

On the other hand, shipowners are willing to accept very low rates to avoid their ship being laid up. The shipowners' options are "warm-stacking" – parking the vessels but keeping them crewed for rapid return to the market – and "cold-stacking," in which they virtually shut the vessels down and send the crews home. Docking still needs to be paid for and loans needs to be repaid, in other words, this is in many cases not a favorable option for shipowners.

Market demand is correlated with the price of oil, which can be very volatile. Effectively, the spot day rates are volatile. Day rates can go from being very low in times of excess capacity, to extremely high when term utilization rate is 100%. Term utilization is the number of vessels on work in a region over the total number of vessels available. Spot contracts usually lasts between 10-14 days and are fixed only days before execution. However, average spot rates should outweigh the occasional risk of vessel unemployment. Long-term contracts is a way to mitigate the risk of a vessel being laid up in times of excess market capacity and low rates.

The offshore supply market is pro-cyclical; in good times, the building activity will be high and the shipyards' order books full. This easily leads to overcapacity if the number of ordered vessels is higher than market demand.

During the last decade, deep-water activity has become increasingly important. Technology advancement are making OSVs ever more fit for harsh conditions, as production move towards new areas when the conventional fields are depleted. A country's offshore geology decides whether there is deep-water activity in the region or not, and some regions have higher occurrence of these conditions than others.

During the last couple of years, the demand for vessels over 3,000 DWT have increased. As of March 4 2015, 276 new PSV are under construction on a global basis. 233 of these are over 3,000 DWT. This is due to the increased activity in deep-water drilling around the world, for which bigger supply vessels are needed. Exploration and drilling activity in regions further north is also a driving factor in this development, because harsh conditions requires more advanced equipment and bigger capacity.

Details about each country's offshore basins, i.e. whether it is deep-water or not, is not easily accessed data. However, the model control for geography in general by including the latitude of a country's capital.

2.1.3 Regions

The main offshore markets are the regions of Northwest Europe, South America (Brazil), West Africa, the Gulf of Mexico and the Indian Pacific. The South Pacific (Australia) also counts as one of the bigger markets. In year 2000, 56% of the supply vessel fleet (both AHTS and PSV) was associated with the activity in Northwest Europe (Farstad, 2012). The region is still one of the most important markets, but growth has stagnated in recent years. The activity in Northwest Europe is with few exceptions executed on Norwegian or United Kingdom continental shelf. Activity on the UK shelf is more in recess compared to the Norwegian shelf, where there are still good exploration activity. The activity is moving northwards to the Barents Sea. Northwest Europe is the only region with a well-functioning spot market.

The Gulf of Mexico is the place of origin for offshore production. The region has seen a steep increase in deep-water activity. Offshore production in the US is divided in four regions: Gulf of Mexico, Pacific, Alaska and the Atlantic region.

Brazil is an important driver of activity in South America. New technology for oil exploration in ultra-deep-water areas has been an important driver for Brazil's growth and important position in the global market.

Offshore West Africa is also a deep-water area. Nigeria is the largest regional offshore producer in West Africa. The region sees an increase in demand for larger vessels as deep-water activity grows. Angola is the second-largest producer, and Equatorial Guinea is third. This is considered a difficult market due to complicated tax and visa regulations.

The regions vary in terms of remoteness of shore base, regulatory regimes and geographical conditions, such as weather conditions and benign or moderate waters.

2.1.4 Cost drivers

The contract between the owner of a vessel and the charterer for the hire of a vessel is called the *charter party*. The charterer is the company that enters into a contract with the owner to hire a vessel. The charterer is usually a major international or state owned oil company, smaller oil companies, large offshore contractors and logistics companies.

The key contract features are date of delivery, port of delivery back to the owner, period of hire, and mobilization/demobilization fee. The period of hire can be a fixed number of days, or the time required to finish the operation. The charterer and the shipowner can agree on options for charterer to extend contract duration. Mob/demobilization fee is a lump-sum payment from the charterer to the shipowner to compensate for relocating the vessel long distances (Ådland, 2013). In some cases, duration of the contract may cause the shipowner to waive the demobilization fee (Jurcevic, Bosic, & Skoko, 2013).

The cost structure consists of fixed costs, mainly capital costs, and variable costs, under which you find maintenance cost, operating cost (OPEX), voyage costs depending on type of trade or operation, and cargo handling costs. Crew cost and fuel are the most considerable operational costs (Strandenes, 2013). Charterer pays the daily rate of hire to the shipowner, and is in addition responsible for port costs and fuel while chartered. Thus, the charterer is the one exposed to risk in case of hike in oil prices. Ship fuel is called bunker. The shipowner pays lubricant oil and other operating costs such as crew costs and insurance.

Crew costs represent about 60% share of the total daily operating expenditure (Vea, 2015)[6]. The crew size is usually around 14-15 people. The crew size does not increase proportionally with vessel size once one gets above very low tonnage. The maritime labor market has become increasingly global during the last decades, and globalization has caused crew costs to become more similar for vessel operators irrespective of the nationality of the ship-owning company. The crew cost varies between countries, depending on the local requirements. Some countries have developed stringent regulations with the purpose of protecting and helping the country's own economy and labor market.

Brazil is an example of this. Creation of a sustainable environment for Brazil's long-term industry and protecting its workforce are fundamental to its government's energy policy. According to sources in the Norwegian offshore supply vessel operator DOF ASA, who count Brazil among their most important markets, operating in Brazil today comes with a portion of tedious bureaucracy, taxes and fees. Getting working visas for foreign workers is one of the complicating issues.

Another thing is the requirements for use of local workforce. An international crew is gradually replaced with Brazilians, and after 360 days, the crew must consist of 67 % local workforce[7]. Further complicating the compliance with tough requirements for local content is a profound lack of skilled workforce. The activity offshore Brazil has increased rapidly the last decade, but Brazil has not managed to educate enough officers for the offshore sector. In some cases, this situation has forced Norwegian operators to double-up a vessels crew with Norwegian officers to compensate for the lack of local competence. Paying double salaries does for obvious reasons make operations more expensive. Argentina has also implemented similar rules.

Another country that is known for its tough requirements for local content and high wage level is Australia. A strong industry labor union has succeeded in pushing wages to levels above the country average.

[6] This is seen from a shipowner's view, when the charterer covers bunker cost (fuel).

[7] Formally, this is referred to as rule RN72.

Countries in West Africa, an increasingly important region for oil exploration and drilling, have not yet developed an equally strict framework of rules and requirements, but here the shipowners run into other difficulties. Slow bureaucratic processes, underdeveloped infrastructure, general security issues and difficulties with money transactions are a few of them (Vea, 2015).

Capital expenditure is the other main cost component. The price of a "newbuild" – the industry term – depends on size and qualifications. There are also regional differences in build costs, among other things due to variations in wage level. However, communication difficulties and cultural differences may cause delays in delivery and thus generate extra costs. The decision of where to build a ship also depends on where the vessel is situated to operate. Some countries require the ship to be built locally to be granted certain operational rights.

Different vessels are needed in different regions dependent on conditions and type of work. In the North Sea, there is demand for bigger and newer vessels designed for harsh conditions. Bad weather, seasons, temperature and deep-water drilling requires well-equipped, big vessels. In comparison, vessels in for instance Southeast Asia do not face the same harsh conditions, and are usually older and smaller.

I control for time-invariant vessel properties such as size and equipment when analyzing the data. The method and implications with this will be further explained in the following sections.

2.1.5 Rules and regulations – the concept of flags

The offshore market is regulated, and there are a number of both international and national rules and regulations. Requirements to "local content", or cabotage, vary between countries. The principle of cabotage refers to a country being entitled to prohibit foreign-flagged vessels from transporting and/or operating between ports in its territory (Ådland, 2013).

All vessels are required to register under a flag in order to sail in international waters. Different rules apply for different flags, according to the registration requirements of the flag nation. Registration confers nationality on a ship and brings it within the jurisdiction of the law of the flag state. The registration allows the ship to travel internationally wherever the citizens of that nation is allowed to travel and works somehow like a ship's passport. Some flags are known as "flags of convenience", and describe ships that are registered in open registries. Open registries allow companies to register their ship independent of nationality, while “traditional” or “national” registries only allow for registration of vessels owned by residents or companies of that country (Brudevoll, 2013). The purpose of sailing under a flag of convenience is to avoid rules and regulations of the nation of origin. Costs and benefits have to be considered when choosing where to register a vessel.

The American offshore giant Tidewater explains in their annual report how national and international rules affect the firm’s operations. The laws of the United States require that vessels engaged in U.S. coastwise trade must be built in the U.S. and registered under U.S. flag. Once a vessel built in the U.S. is registered under foreign flag, it cannot thereafter engage in trade along the U.S. coast. In other words, sailing from port to port along the U.S. coast is forbidden. Of Tidewater’s total 328 vessels as of March 2013, only 42 vessels were registered under U.S. flag (Tidewater Inc., 2013).

Another example national regulation is Norway. Norway offers two types of flags, NOR and NIS. NIS is an abbreviation for Norwegian International Ship Register. Vessels sailing under a NIS flag are subject to Norwegian jurisdiction, but not allowed to carry cargo or passengers between Norwegian ports (cabotage). The NIS flag and accompanying rules were established in 1987, with the purpose of improving Norwegian-owned vessels’ competitiveness abroad, protecting Norwegian workforce and ensure the registration of Norwegian vessels under the Norwegian flag (Sjøfartsdirektoratet (Norwegian Maritime Authority), 2014).

Even though rules protecting national waters might lower competition, the same local rules constitute a potential source of higher operational cost. For instance, mandatory use of local workforce in high-cost countries will result in increased day rates as crew cost increase.

I will treat the concept of flags as an example of industry regulations. Controlling for which flag the vessel flies is not done explicitly in the specified model, but indirectly through controlling for individual vessel characteristics that do not change across time. Moreover, if flags indeed represent an unobserved determinant of day rates, these unobserved factors related to country are thoroughly dealt with. See section 3.5.2 “Clustering of standard errors”.

Overall, the supply vessel market is global, and subject to a wide range of different rules and regulations. The market is unique in the sense that a vessel can change between countries, and thus the same individuals are exposed to different level of institutional quality dependent on where in the world the operation is to take place.

3. Methodology

This section will describe the applied econometric techniques. The data set used in this thesis has a panel structure. First, I will briefly introduce the conditions for unbiased and consistent OLS estimates, and argue why these conditions no not hold for my data. Second, I will explain the concept of fixed-effects estimation, and what problems I solve with this approach. Lastly, I introduce the concept of instrumental variables, and explain in what way I use it. The theory presented is based on Wooldrigde (2013) and Angrist & Pischke (2009) if nothing else cited.

3.1 OLS with panel data

For the ordinary least squares (OLS) method, there follows five assumptions under which the OLS estimators are unbiased and consistent. These are known as the Gauss-Markov theorem. I will concentrate on two of these assumptions, namely the zero conditional mean assumption and the homoscedasticity assumption.

- Zero conditional mean: The expected value of the error u is zero given any of the explanatory variables, $E(u|x_1, x_2, \dots, x_k) = 0$.
- Homoscedasticity: The variance in the error term is constant, i.e. the error term has the same variance given any values of the explanatory variables. This assumption is known as the homoscedasticity assumption: $Var(u|x_1, \dots, x_k) = \sigma^2$.

The assumption of zero conditional mean is not likely to hold if the model is not specified correctly, or if an important determinant of the regressand is omitted. A violation of this assumption will lead to biased OLS estimates, and invalidate statistical inference.

That data has a panel structure is common in empirical research. Panel data is a data set constructed from repeated cross sections over time. It consists of both a cross-sectional and a time series dimension. The panel data set used in this thesis has a three-dimensional structure, with i individuals in j groups over time t.

The panel data error term is usually written as a composite error, consisting of an individual time-constant, unobserved error term and an idiosyncratic error term:

$$v_{ij} = a_i + \varepsilon_{it}$$

Panel data techniques are based on the particular structure of the error term, and how to treat the time-constant effect a_i.

Balanced panel data have an equal number of observations for each individual in every period. If this is not the case, the data set is unbalanced. Modern statistical software like Stata is capable of dealing with unbalanced panels.

Unbiased and consistent estimates are the key to correct econometric inference. An estimator whose expected value, i.e. the mean of its sampling distribution, equals the population value is unbiased. A consistent estimator is one whose distributions of estimates become more and more concentrated near the true value of the parameter being estimated, i.e. the estimated parameter gets closer to the population parameter as the sample size increases.

As explained above, the error term in panel data is composite. So, if the zero conditional mean assumption is to hold, the explanatory variables x_{it} have to be uncorrelated with both a_i and u_{it}. If we think that one or more of the explanatory variables are correlated with a_i, the OLS will be biased. This is best known as omitted variable bias (sometimes also referred to as heterogeneity bias).

Omitted variables can cause a positive or a negative bias. Establishing the direction of the bias is fairly easy in a simple regression model with only one explanatory variable, but more difficult when dealing with multiple regressors. Correlation between a single variable and the error term causes bias in all the OLS estimators (Wooldrigde, 2013, s. 96). In most cases, it is impossible to control for all sources of variation in a model.

Fortunately, methods have been developed to deal with such issues in panel data.

3.2 Fixed effects

Fixed-effects estimation, sometimes referred to as the use of time-demeaned explanatory variables, is a way to eliminate the effects of fixed differences between individuals on outcome. This is a widely used method when working with panel data.

The key to fixed effects estimation is that the unobserved individual effects on outcome appears without a time subscript in the linear equation. It is assumed that the outcome y is dependent on unobserved individual fixed effects, and time-varying explanatory variables, here represented by x_{it}. The following general equation represents a fixed effects model in the case of one explanatory variable:

$$y_{it} = \beta_0 + \beta_1 x_{it} + \lambda_t + \alpha_i + \varepsilon_{it}$$

Here, α_i is the individual fixed effect and λ_t is a year effect. The causal effect of interest is the coefficient β_1. This effect can be estimated by treating α_i as a parameter to be estimated. The same is the case for the year effect. The unobserved individual effects are coefficients on dummies for each individual, while the year effects are coefficient on time dummies. In large data sets, the solution is not to include dummies for all of the individuals. Subtracting the individual averages and estimate the deviation from mean gives the same estimated result.

The first step is to calculate the individual averages:

$$\bar{y}_i = \bar{\beta}_0 + \beta_1 \bar{x}_i + \bar{\lambda} + \alpha_i + \bar{\varepsilon}_i$$

Subtracting the mean from the fixed effect equation gives

$$y_{it} - \bar{y}_{it} = \beta_1 (x_{it} - \bar{x}_i) + (\lambda_t - \bar{\lambda}) + (\varepsilon_{it} - \bar{\varepsilon}_i)$$

The time-constant unobserved individual effects disappear in this last equation, because they are constant over time (and so is their mean value). However, statistical software does report it. The intercept now interprets as the average effect of all individual unobserved effects on outcome. This has no practical significance.

Statistical software packages like Stata routinely compute fixed-effect estimates.

3.3 Dummy variables

Above, the practical way to control for the “year-effect” is to include time-dummies in the model. Dummy variables for each year isolate certain periods that may be systematically different from other periods covered by a data set. Panel data observations are spread across time. In brief, including one dummy variable for each year allows the intercept to differ across periods.

This method is widely used in panel data analysis. The omitted year represents the reference year. The dummy variable coefficient interpretation is, when controlling for other factors, how the dependent variable is affected in this year compared to the reference year.

3.4 Instrumental variables

Even though fixed-effects estimation is sometimes a good method for removing unobserved individual effects that do not vary across time, there might still be cases where the error term ε_{it} is correlated with one or more of the explanatory variables. Instrumental variables are useful tools when there is suspicion that one of the explanatory variables in a model might be endogenous, that is, correlated with the error term. This is the conventional way of using the IV method. I will use it for a slightly different purpose. My main focus does not lie on isolating a causal effect, but to see whether the instrumented variable might help explain the effect of the instrument. This will be further explained in section 6.

3.4.1 Instrumental variables and 2SLS

Regular OLS regression may fail to produce convincing estimates of causal effects. The instrumental variables (IV) method is a way to deal with this issue. The IV method solves the statistical simultaneous equations problem by using variables that appear in one equation to shift this equation and trace out the other (Angrist & Pischke, 2009). Isolating causal effects is not the main point in my use of IV, but serves as good framework for explaining the method.

In econometrics, instrumental variables (IV) and the two-stage-least-squares (2SLS) method is often referred to interchangeably. Instrumental variables leaves the unobserved variable in the error term, but in contrast to regular OLS estimation, it recognizes the presence of the omitted variable. The parameters for calculating the 2SLS estimate is best understood as regression coefficients.

The model that contains the variable of interest, which is suspected of being endogenous, is called the structural equation. To isolate the causal relationship, I have an instrumental variable z_i that I assume is uncorrelated with the error term, but correlated with the endogenous explanatory variable. The link from the instrument z_i to the causal variable of interest x_i is called the *first-stage equation*. The Greek letter φ represents this link:

$$x_i = \beta_0 + \varphi z_i + \beta_1 x_{i1} + v$$

The direct effect from the instrument on outcome is called the *reduced form*. This effect is described with the letter ρ:

$$y_i = \pi_0 + \rho z_i + \pi_1 x_{i1} + u$$

The causal effect of interest then is determined by the ratio of reduced form on the first stage. Lambda is the chosen letter to represent this ratio, which can be written as a covariance's ratio called the *IV formula*:

$$\lambda = \frac{\rho}{\varphi} = \frac{Cov(y_i, z_i)}{Cov(x_i, z_i)}$$

Computing the ratio λ can be done in two stages. After running the first-stage equation, the fitted values, $\hat{x}_i$ are predicted. In the second stage, the outcome y_i is regressed on the fitted values. Here, λ is the coefficient of the fitted values. Statistical software packages generates this ratio in one operation, which limits the scope of mistakes and produce appropriate standard errors. Doing these two stages by running each regression for itself does not produce the correct standard errors needed to measure sampling variance, and test statistics would be invalid. Including additional control variables comes with no extra cost, provided they appear in all stages.

A good instrumental variable must fulfill two conditions. First, it must be exogenous. That is, the covariance between the instrument z_i and the error term in the structural equation must equal zero. This is the same as stating that z_i is uncorrelated with any other determinants of the dependent variable. This is referred to as the exclusion restriction. In other words, the instrument is exogenous if the instrumented variable is the only channel through which the instrument affects the dependent variable. The exclusion restriction is not possible to test, because the error term is unobserved, and reasoning is the only way to decide whether it holds.

Second, the instrument must be relevant. Relevance is determined by the covariance between the instrument and the original explanatory variable that is suspected of being endogenous.

For an instrument to be relevant, the relationship between the instrument and the instrumented causal effect cannot be zero, formally written as $Cov(x_i, z_i) \neq 0$. If there is no observable effect of z_i on x_i, the chosen instrument is not relevant. Therefore, if the estimates produced in the first stage are only marginally significantly different from zero, the IV estimates are unlikely to be very informative (Angrist & Pischke, 2009).

Whether the exclusion restriction holds or not will not be the main issue when I later use the 2SLS method. I will use instrument variables with the objective of investigating whether a set of chosen channels are relevant, and not necessarily establish a causal relationship. In other words, the 2SLS estimate is not of great importance, but the first-stage equation is. This diverges from the conventional way of using IV.

3.5 Standard errors

3.5.1 Robustness

Heterogeneity in standard errors is rather the rule than the exception. Heterogeneity occurs when the variance of the error term is not constant given each of the explanatory variables, as follows from assumption 5 above. To deal with this issue, it is possible to use the option of heterogeneity-robust standard errors when running regressions. The t statistics will get smaller when using robust standard errors, and the confidence intervals wider[8].

Testing for heterogeneity is possible, but not always necessary. Economic theory rarely gives any reason to believe that the errors are homoscedastic. It therefore is prudent to assume that the errors might be heteroskedastic. Nothing is lost if I use heteroskedastic-robust standard errors in the case where the standard errors are completely homoscedastic. The safest choice is to opt for heteroskedasticity-robust standard errors if I do not have compelling reasons to believe that my standard errors are homoscedastic, which I do not.

[8] The t-statistic formula: $t = \frac{\hat{\beta}_j}{se(\hat{\beta}_j)}$

3.5.2 Clustering of standard errors

Dealing with standard errors in three-dimensional panel data is challenging. The Fixed-Effects estimation method removes time-constant individual effects, a_i, but there might also be time-constant effects related to country in this case that is not controlled for through FE estimation.

Traditional cross-section inference relies on the basic assumption that all observations are independent, i.e. treated as a random draw in each cross-section. Homoscedasticity means that the errors in a regression model have constant variance conditional on the explanatory variables (Wooldrigde, 2013). This is the same as assuming no serial- or autocorrelation in the error term. This assumption is rather unrealistic. In data with a group structure, for instance where each country represents a group in which individuals are observed, there is reason to believe that the vessels share some kind of common exposure from the country that affect the obtained day rates. By overlooking the so-called intraclass-covariance, we tend to underestimate standard errors. The standard errors are subject to what have been named Moulton bias (Moulton, 1986).

As a rule of thumb, standard errors, confidence intervals and test statistics that are valid in a large set of cross-sections should be calculated under the weakest assumptions (Wooldrigde, 2013, s. 691). Clustering standard errors is a common way to deal with serial correlation in the idiosyncratic errors. In FE estimation, clustering is applied to the time-demeaned equation.

However, clustering standard errors does not always offer a straightforward solution. In cases where panels are non-nested within clusters, the clustering process is somewhat complicated. Non-nested panels means that the group effect is not constant on individuals, because individuals move across groups. Clustering standard errors on individual-level will not improve inference much, because the effect of this is the same as using heteroskedasticity-robust standard errors.

For example, a data set where firms represent the panel identity and municipal the group identity, the group effect from the individual municipality will be constant on the firms at least in the short to medium run. However, if individuals move across groups, the effect is not constant. Clustering standard errors on group-level only is therefore not feasible, because the group effect on individuals vary dependent in what group the individual currently is present.

A possible solution to this problem is two-way clustering, where standard errors are clustered on both individual and group level. The intraclass covariance, which is the possible source of the country effects that will underestimate standard errors, is now taken into account.

3.6 Testing the model

Heterogeneity, caused by omitted variables, will cause biased estimates and invalid test statistics. Robustness tests of the model is a way to discover how the relationship of interest changes in response to excluded or added explanatory variables. A way to think of this is how the estimated coefficient reacts when factors are "taken out" of the error term. If the variable is "left" in the error term, this will cause estimates to be biased, because the variable is relevant determinant of the dependent variable. If the output changes drastically when an independent variable is added or excluded, this gives reason for further discussion about the independent variables' importance for disclosing the relationship of interest.

I will perform robustness checks and discuss the output in section 5 "Baseline results". The FE approach in itself is a way to deal with biased estimates, because this eliminates time-invariant individual effects from the error term. I will not formally test for heteroskedasticity, but I argue that it is almost certainly present due to group effects. By clustering standard errors on both individual and group level and see if this have implications for the significance of the results, I control for both potential heteroskedasticity and serial correlation in the error terms.

4. Data and empirical strategy

4.1 Data survey

Offshore market data are collected from ODS-Petrodata's MarineBase. MarineBase covers detailed vessel data on all the major offshore markets. Founded in 2002, ODS-Petrodata is an impartial provider of energy information covering rigs, offshore field construction and marine support vessels. The company brings together more than 35 years of offshore data built on the legacies of its predecessor companies. ODS-Petrodata was in 2011 acquired by IHS. IHS is a global data giant provide extensive services in the business of market intelligence used by both private companies and governments in decision-making processes (IHS.com, 2015).

From this database, I get information on fixture dates, start date and end date of each contract, chosen vessel characteristics and most importantly day rates. All day rates are “earned” day rates, i.e. the rates that have actually been paid for a vessel. The data contains PSVs in all sizes. In addition, all of the vessels do have a dynamic positioning system.

As measure for institutional quality, I use the Polity IV data series[9]. This is a widely used measure in academic research. The composite Polity score is calculated as the difference between a country’s democracy and autocracy score. The "Polity score" captures this regime authority spectrum on a 21-pont scale ranging from -10 (hereditary monarchy) to +10 (consolidated democracy). So-called “interregnums”, “interruptions” and “transition” state of governments are given the values -77, -66 and -88 (The Polity Project, 2015). I treat these as missing values.

The use of instrumental variables is inspired by (Acemoglu & Johnson, Unbundling Institutions, 2005). In their article “Unbundling Institutions”, they aim to discover what type of institutions have most effect on a country’s economic development. The two categories used for institutions are *property rights institutions* and *contracting institutions*. As a proxy for property rights institutions, they use the average protection against government expropriation risk in a country as assessed by the international agency Political Risk Services.

[9]Data available from http://www.systemicpeace.org/inscrdata.html

Political Risk Services reports a value between 0 and 10 for each country and year, with zero indicating the lowest protection against expropriation.

For contracting institutions, they use the legal formalism as developed and used by Djankov, Rafael, Florencio, & Andrei (2002) and Djankov, La Porta, Lopez-de-Silanes, & Shleifer (2003). The legal formalism index measures substantive and procedural statutory intervention in judicial cases at lower-level civil trial courts. A greater degree of legal formalism creates additional costs for enforcing private contracts. Djankov et al. (2003) measure the extent of these costs by surveying expert opinions of lawyers in an international network of law firms in 109 countries. They then construct an index of legal formalism that is comparable across countries. The index ranges from zero to seven, where seven means a higher level of control intervention in the judicial process.

I take use of the two variables *average protection against expropriation by government* and *legal formalism* from the dataset as composed and used by (Acemoglu & Johnson, Unbundling Institutions, 2005)[10].

Gross Domestic Product (GDP) per capita data is collected from the World Bank's World Development Indicators[11]. GDP is given in current international USD, purchasing power parity (PPP) adjusted. Oil price data is also from the World Bank.

Data for world oil production is from British Petroleum's Statistical Review[12].

Finally, country-level data on country-size, latitude of capital and other geographical characteristics is gathered from CEPII (Mayer & Zignago, 2011)[13].

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[10] Data available from the authors' home page: http://economics.mit.edu/faculty/acemoglu/data/aj2005

[11] http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD

[12] Data available at: http://www.bp.com/en/global/corporate/about-bp/energy-economics/statistical-review-of-world-energy.html

[13] Data available at: http://www.cepii.fr/CEPII/fr/bdd_modele/download.asp?id=6 (login required).

To use data from various sources requires thorough research and data formatting. I clean the data so that all country names match prior to merging, in cases where standard three-letter country codes were not available.

4.2 Empirical strategy and treatment

The data structure is three-dimensional, with observations of individuals i in a country j over time t. Each vessel has a unique IMO number, which serves as the identification variable i. Each contract is assigned a country j where the work will be executed and under whose legislature the contract applies to. Time t represents a given year from 1995 to 2013.

I calculate the mean day rate for each vessel in a specific country in a specific year. The contracts do not necessarily end by the end of a year, so the data needs to be treated before calculating the correct mean value for each vessel-country-year. The concept of vessel-country-years is something I will refer to when further describing the data. I want the mean value of all day rates for contracts that started in a specific country in a specific year. So that when a vessel changes country in one year, I capture the potential difference in Polity score between the two countries.

First, I rectangularize the data set, so that all interactions of IMO number and start date of a contract is available, i.e. all dates for all years 1995-2013 are filled in for all vessels. Then, the day rate of a contract is filled in for as many days as the contract lasts. Further, I collapse the data so that I get the mean day rate one vessel obtained in all the countries visited for all vessel-years. The panel identifier now is the vessels IMO number.

The dependent variable in my model interprets as the mean day rate in nominal US dollars per vessel-country-year. For instance, the mean day rate a vessel earned in Norway in 2005. If the vessel relocates to Angola during 2005, the contract day rate earned in Angola that year is calculated separately. For the sake of avoiding outliers, I delete the 1 % and 99 % percentile of the day rate observations.

Why calculate the mean earned day rate for each country-year? One, the explanatory variable of interest, namely Polity, has annual scores. If I were to measure the effect of a country's Polity score in one year on the earned day rate of a random contract in the same year, I would have to argue that there is no unobserved changes in Polity during that year.

Two, the obtained day rate can be compared with a vessel's wage in a given year. The average wage is the average of all contracts that given year. Long and short contracts are equally weighted. To put this clearly, consider a vessel going on a one-day contract all days during one year in a country. The rate, for the sake of illustration, is USD 1. The total amount is $1 times 364 days. The last day of the year, something happens and the contract is prolonged to last 364 days into the next year. The average rate in this case will be

$$\frac{1\times364+364\times1}{365} = 2 * \left(\frac{364}{365}\right) \approx 2.$$

If I simply calculated the average, the math would be

$$\frac{1+364}{2} = \frac{365}{2} \gg 2.$$

I.e., the short contract would be heavily overweighted.

Third, this reduces the amount of noise in my data. Regressing all day rates as given by start date would result in higher standard error values and less efficient estimates.

Furthermore, I calculate the median duration of all contracts fixed for each vessel in all years. The median is a more eligible measure than the mean in this case, as contract duration can vary greatly during one year for each vessel. This depends on whether the vessel is placed in the spot or term market, or switch between the two.

4.3 The model

The baseline model, where all variables are the time-demeaned:

$$\ddot{usdrate}_{ijt} = \beta_1 \ddot{polity}_{ijt} + \beta_2 \ddot{latitude}_j + \beta_3 \ddot{oilproduction}_{tj} + \beta_4 \ddot{medianduration}_{ijt} + D_{1,1995}\ddot{year}_{1995} + \cdots + D_{19,2013}\ddot{year}_{2013} + \varepsilon_{jt}$$

The dependent variable $usdrate$ is the mean day rate for a vessel in a given country in a given year. The time-demeaned $\ddot{usdrate}_{ijt}$ is the influence on day rates following deviations from the mean of the explanatory variables. The explanatory variable of interest is $polity$. In addition, I control for geographical variation, oil production as measure for demand and the median duration of contracts.

In the model, i represent the individual vessel, j is the country denominator and t represents the years 1995 through 2013. Latitude is the latitude in degrees for a country's capital. Latitude is constant for each capital across time, except in cases where a country changes capital. Oil production is the country's oil production in a given year. Median contract duration is the median duration of contract length in number of days for a vessel in a country-year. The model contains dummy variables for all years, where 1995 represents the base year.

Median contract duration is the median of all contracts a vessel enters in that year. If no new contract terms were started, for instance if the vessel is on a contract that started the year before, no values for contract duration is reported. This way, by including the median contract duration as an explanatory variable, I only regress a country's Polity score on mean day rates in years were the rate was agreed upon and fixed. This makes sense, because a change in Polity score the next year will anyway not affect day rates fixed the year before; the rate is constant throughout the contract period.

Market analysts often uses term utilization as a measure for capacity in the market when they predict future demand. However, I consider term utilization rates irrelevant in this model. One, this model is not predictive. Two, utilization rates are published monthly and there will be very little variation in year averages. The term utilization is a medium to short-term measure. The utilization rate is in general most important for spot market prices. However, I use the term utilization rates for robustness checks of the main result.

For a detailed description of the variables, see Appendix.

4.4 Descriptive statistics

The total number of observed PSVs is 765. The number vary across time, as old vessels are laid up and new ones enter the market. The data contain information on fixtures in the years 1995 to 2013. A table of observations counted by country and by year is in Appendix (Table 10-1 and Table 10-2). UK, Norway, United States and Brazil are the most dominating markets in terms of number of observations. For observations by year, the number increases in recent years. This is due to the fleet growth in fleet during the last decade.

Table 4-1 Summary statistics

	Count	Mean	Min	Max	Std. Dev.
Day rate (USD)	2469	19381.4	4200	53603	10313.2
Polity	2469	9.26	-10	10	2.74
Latitude in degrees	2469	43.4	-33.9	59.9	24.3
Oil production (1000 barrels/day)	2469	2538.8	83	11525	1915.8
Median contract duration	2469	292.1	1	3836	571.3
DWT	2469	3442.1	450	7620	1139.4
BHP	1904	7085.8	1500	15791	2471.2
Vessel age	1904	11.3	-1	40	8.77
Buildcost (MUSD)	1125	25.4	0.82	71.8	13.1
Year	2469	2007.1	1995	2013	5.10

NOTE: The table displays summary statistics for all variables. Day rates are given in nominal USD. Polity score is measured on a scale from -10 to 10, where 10 means that the country has good (democratic) institutions. Latitude in degrees is the latitude of a country's capital. Oil production is measured in annual average of daily production, measured in 1000 barrels. Median contract duration is the median duration of all contracts that a vessel enters in each year. DWT stands for deadweight tons, and is a measure of the vessels freight capacity. BHP is an abbreviation for break horsepower, and measures the engine capacity. Vessel age is the number of years since the vessel entered service. Buildcost is the price in million USD that was paid for the construction of the vessel. Year is a dummy variable.

A histogram of the distribution of day rates is shown in Appendix (Figure 10-1). The observations are somewhat skewed towards zero. Exact inference requires that the error term is independent of the explanatory variables and is normally distributed with zero mean variance. However, normality plays no role in the unbiasedness of OLS, nor does it affect the conclusion that OLS is the best linear unbiased estimators under the Gauss-Markov assumption (Wooldrigde, 2013, s. 167).

Not all vessels change country during the observation period. Time-demeaning observations eliminate the effect of Polity on vessels that stay in the same country throughout the whole observation period. Because a minimum of variation is required, that means that vessels need to switch between countries with different Polity scores or that the Polity score changes over time. If the Polity score for some reason is constant, the effect is eliminated.

Table 4-2 Number of countries visited per vessel

	Count	Mean	Variance	Std. Dev.	Min. value	Max. value
Sum	1119	1.83	0.81	0.90	1	5

NOTE: The table shows how many countries vessels visit on average. A value of 1 means that a vessel only visit one country. "Count" refers to the total number of vessel and country combinations, and must not be confused with total number of vessels observed.

The table describes how many times a vessel changes country. The values indicates number of countries visited. In other words, the average value of 1.83 means that a vessel on average visits two countries, i.e. change country once. The maximum number of countries visited is six. As much as 507 vessels only visit one country. This implies little variation in data. Alternative measures for dealing with this will be further discussed in the next section.

Table 4-3 (below) shows the number of years registered per vessel. Some vessels are only observed one year, while the maximum is 30 country-years. The number is higher than the 19-year period between 1995 and 2013, because in some years, a vessel changes country. I calculate mean day rate earned in each vessel's country-year. The point is that if a vessel goes from one country to another with a different Polity score, this change will influence the calculated earned day rate. For instance, consider a vessel that has been operating in Norway in 2003, which has a Polity score of 10. The vessel is relocated to start a contract in Brazil the same year or the next, which has a Polity score of 8. With FE estimation, the influence of Polity score on day rate from that shift is the deviation from mean Polity score for all observations of that specific vessel.

Figure 4-1 (next page) shows the global development in mean day rates for all vessel-years together with average annual Brent spot price measured in nominal USD per barrel. The vessel day rates are quite volatile. The day rate and the oil price are closely related. A drop in oil prices will cause lower activity in the oil and gas sector, which again lead to lower demand for offshore services. In 2008, the oil prices dropped due to the financial crisis and so did the PSV day rates.

Table 4-3 Number of country-years observed per vessel

	Count	Mean	Variance	Std. Dev.	Min. value	Max. value
Sum	2468	7.14	36.23	6.02	1	30

NOTE: Descriptive statistics for number of country-years observed for all vessels. Only years where the vessel actually started a contract in the respective countries are included.

Figure 4-1 Earned day rates (Platform Supply Vessels) and oil price (Brent spot)

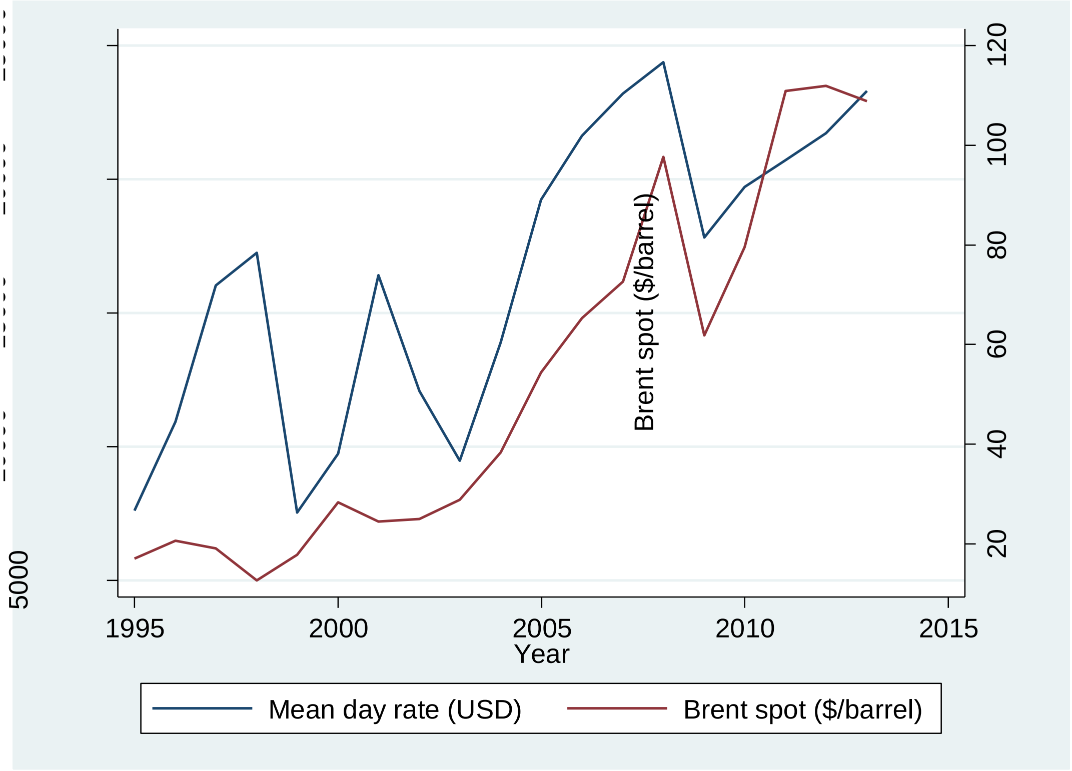


Figure 4-2 Mean earned day rates by country

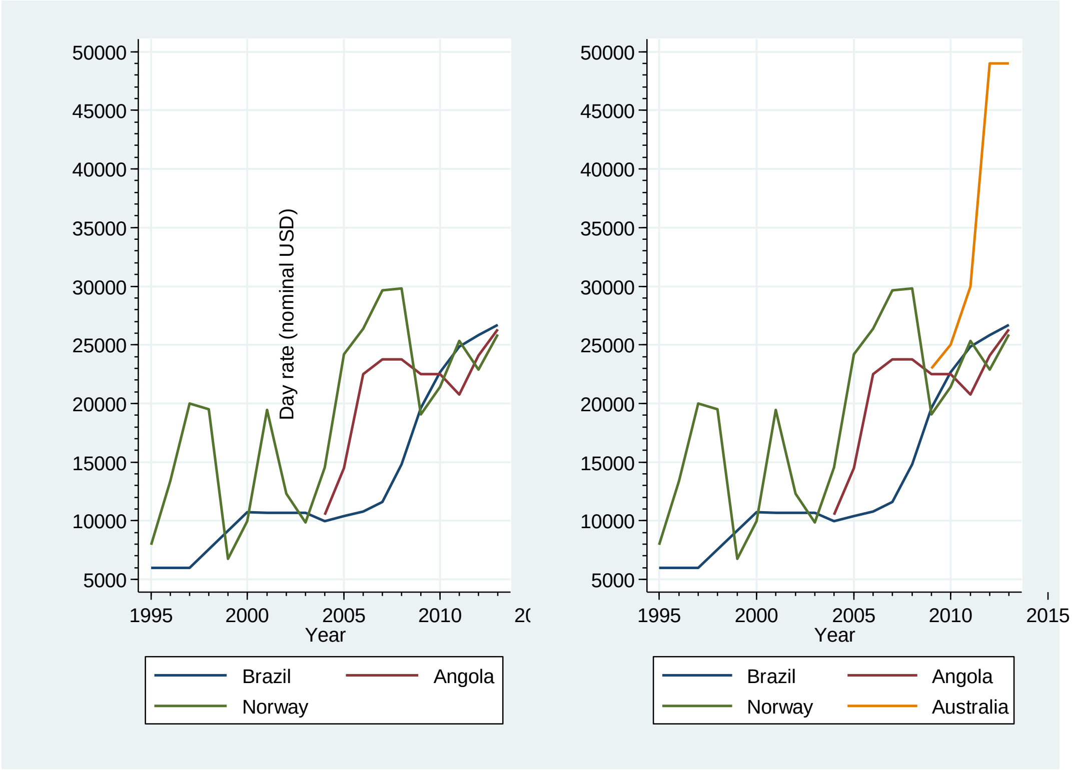


Figure 4-2 above displays day rates observed in Brazil (South America), Norway (Northwest Europe), Angola (West Africa) and Australia (South Pacific). These countries represent one of the leading markets in their respective regions.

Day rates in Norway follow the same path as global development. Because Norway is one of the markets with the most observations, the day rate level from this region is very dominating when calculation the world average. A figure of the global average day rates compared with Norway and UK is in the Appendix, Figure 10-2. Rates in Brazil have seen a steady growth, and Brazil was the only country of the four where day rates did not drop because of the financial crisis. We see that the day rates in Australia lie high above the level in the other countries displayed in graph.

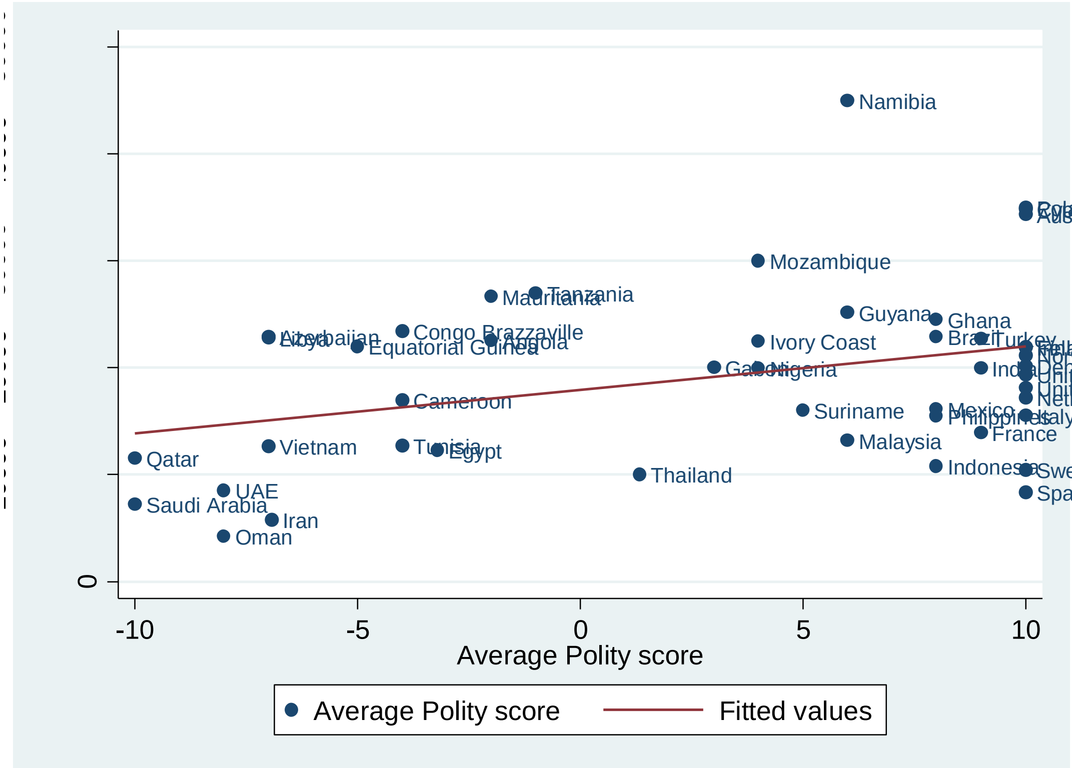
5. Baseline results

In this section I will present and interpret the baseline results. Furthermore, I will discuss the results and suggest qualitative explanations by putting them into perspective[14].

5.1 Results

Figure 5-1 suggests a positive relationship between day rates and Polity score. This is the relationship of main interest.

Figure 5-1 The relationship between mean day rates and average Polity score



Countries in the Middle East region, like Qatar, Saudi Arabia and the United Arab Emirates all have low average Polity scores over across the observation period. Hiring a PSV is, on average, cheaper in this region. In the other end, we have the typical western countries, including all the countries belonging to the Northwest Europe region (Norway, UK, Denmark,

[14] I sometimes use the expression «cause» freely, for the sake of variety in language. However, I am not establishing a *causal* relationship of variables on day rates, as OLS estimation only disclose correlation.

Netherlands, France, etc.). However, just plotting the values is merely suggestive. Low rates in the Middle East might be due to smaller vessels, mild environmental conditions and so on. Empirical testing of this relationship allows us to control for such factors.

Table 5-1 (next page) shows the output from four different regressions. The output from regression (1) is the FE estimates. Regression (2) shows the OLS estimates on the same model. Regression (3) is OLS estimation where vessel-specific characteristics are controlled for, like freight capacity, engine capacity, building cost and age[15]. Because this reduces sample size by half, I have added the results from a regression number (4), where I use the fixed-effects approach on same sample as the expanded model.

The dependent variable is mean day rates earned in a given country in a given year, referred to as a country-year. The FE estimator eliminate all time-invariant variables connected to the vessels. These will therefore not influence day rates.

The output from regression (1) is the baseline result. The relationship between day rates and Polity score is significant when standard errors are robust to heteroskedasticity. One unit increase in Polity score yields an increase in mean day rate that a vessel earns in a country-year of US$ 336.8. However, unless the time-invariant factors removed by the FE estimator are the *only* factors that causes biased estimates, I cannot establish that this is a causal relationship. Considering that the mean day rate in the sample is above 19,000 USD, the economic significance is not substantial.

Reporting the OLS estimates reveals the difference in the relationship of interest when the variables are not time-demeaned. The estimated coefficients on Polity is not very different from each other, which might indicate that the fixed-effects is economically not very significant. Nonetheless, the estimate is slightly smaller. The OLS estimate is suffering from a positive omitted variable bias.

Regression (3) shows OLS estimation on a model where certain vessel characteristics are controlled for. Regression (3) aim to control for this by including controls for size, engine

[15] Age is not constant over time. However, because there are not enough observations of vessel over longer periods, age was eliminated from the time-demeaned equation.

capacity, age and building cost. This reduces the estimated coefficient of Polity. Still, the correlation between day rate and Polity score is significant and positive.

However, the output in (1) and (2) is not comparable with (3) and (4). Lack of observations for vessel properties reduce the sample size by half. By using the fixed-effects method on the reduced sample size, I observe that when controlling for all time-invariant factors, the effect of Polity on day rate is no longer significantly different from zero.

Table 5-1 Baseline results

	(1) FE, main model	(2) OLS, main model	(3) OLS, expanded model	(4) FE, expanded model sample
Polity	336.8**	372.6***	224.1**	137.3
	(108.9)	(61.58)	(71.88)	(87.69)
Latitude in degrees	-95.62***	-38.59***	-94.26***	-110.0***
	(15.87)	(9.913)	(10.84)	(19.15)
Oil production (1000 barrels/day)	0.953***	-0.871***	-0.686***	0.312
	(0.274)	(0.110)	(0.162)	(0.414)
Median contract duration	-2.211***	1.864***	-0.367	-1.907**
	(0.486)	(0.428)	(0.397)	(0.618)
DWT			2.205***	
			(0.474)	
BHP			0.467**	
			(0.172)	
Vessel age			-288.8***	
			(51.37)	
Build cost (MUSD)			-46.21	
			(32.69)	
Dependent variable	Mean day rate	Mean day rate	Mean day rate	Mean day rate
Observations	2469	2469	1125	1125
R-sq.	0.370	0.0500	0.167	0.360

Standard errors in parentheses
NOTE: The table shows the baseline regression output. Year dummies are included in all models, but not reported. For a complete table including year dummy coefficients, see Appendix. All standard errors are heteroskedasticity-robust.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.2 Model heterogeneity and robustness

A way to check for heterogeneity is by using interaction terms. Interaction terms allow the partial effect of an explanatory variable, to depend on the level of another variable, and vice versa. The coefficient on one variable, measure the partial effect of that variable when the other variable included in the interaction term is equal to zero (Wooldrigde, 2013). I will use interactions with Polity and the other explanatory variables from the main model, with the purpose of checking whether the effect of Polity changes for different values of the explanatory variables. The results are displayed in Table 5-2 below.

Table 5-2 Model with interaction terms. FE estimates.

	(1) Day rate (USD)	(2) Day rate (USD)	(3) Day rate (USD)
Polity	331.7^{**}	132.4	359.2^{**}
	(118.5)	(111.8)	(113.5)
Latitude in degrees	-97.56^{*}	-96.24^{***}	-96.05^{***}
	(39.45)	(15.71)	(15.87)
Oil production (1000 barrels/day)	0.953^{***}	-0.0410	0.949^{***}
	(0.275)	(0.246)	(0.273)
Median contract duration	-2.209^{***}	-2.171^{***}	-1.893
	(0.492)	(0.482)	(0.991)
Latitude*Polity	0.231		
	(4.519)		
Polity*Oil Production		0.120^{***}	
		(0.0260)	
Polity*Median Duration			-0.0392
			(0.109)
Observations	2469	2469	2469
R^2	0.370	0.372	0.370

Standard errors in parentheses
NOTE: The table shows the FE estimates from the main model with added interaction terms. Year dummies are included in all models, but not reported. All standard errors are heteroskedasticity-robust.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The baseline result is significant and positive when and interaction variable between Polity and latitude is included, as in regression (1), and between Polity and median contract duration, as in model (3). However, the interaction term in regression (2) shows that there is a significant non-linear relationship between Polity and oil production. The interpretation of the coefficient is that the effect of Polity on day rates is higher in countries with higher oil production. Lastly, the coefficient on Polity is no longer significant from zero in regression (3). Because of strong correlation between Polity and the interaction term, the separate effects on day rate are hard to distinguish.

Robustness can be described as how well the estimated coefficients respond to changes in the error term. If the regression output changes drastically, the results are not robust. All results from robustness checks is found in the Appendix, Table 10-4.

Clustering standard errors is method used to check for robustness. Because of intraclass correlation due to group effects, I cluster the standard errors on both individual and group levels, in this case that means on vessel and country. Sometimes, clustering can be crucial for drawing correct statistical inference. As we see in Table 10-4 in the Appendix, the relationship between Polity and day rate remains significant when standard errors are robust to both heteroskedasticity and serial correlation. Country-level effects does not obliterate the estimate significance.

Another way to check whether results are robust or not is to regress the dependent variable on different combinations of the explanatory variables. One way to look at it is how the regression output changes when potential covariates are “taken out” of the error term. The Appendix Table 10-4 shows the results when explanatory variables are added one by one. The relationship between day rates and Polity is significantly different from zero only when the median duration of contracts is included in the model. Adding potential covariates such as the term utilization rate and oil price does not alter the baseline results.

5.3 Analysis and discussion

The positive relationship between Polity and day rates may appear surprising at first glance. Assume that countries with lower Polity score are less politically stable and more risky. The party with the operational risk, which in this case is the shipowner, will require a risk premium as compensation. Why does better institutions drive rates upwards, when factors such as individual properties, geographical location, duration of contract and market demand are controlled for?

A potential explanation to this positive correlation is through the causal relationship of institutions and economic growth. If countries with good institutions indeed are richer, the general higher price level of goods might cause higher prices also in the offshore supply market[16]. Consider the option in which countries with good institutions more able to construct a framework for sustainable protection of their own economy. Requirements to local content can drive prices up when the requirements influence the main cost drivers. Crew cost is a prime example. If a shipowner is required to use local workforce, and the wage level in the country is relatively high, this will drive OPEX up, which again is reflected in higher day rates.

In cases where vessels do not change between countries, which is the case for a substantial number of vessels in the sample, the effect of crew costs is eliminated when using the FE approach. However, because the OLS estimates also report a positive and significant correlation when crew costs are not controlled for, the hypothesis of high crew costs in countries with higher institutional quality holds. OLS estimation does not eliminate the influence of time-invariant variables on day rates.

The positive coefficient on oil production indicates that an increase in a country's oil production implies increased mean day rates earned for a vessel in the corresponding country-year. The correlation is positive despite the fact that Saudi Arabia is substantial outlier, with the by far highest reported oil production and low day rates. See Figure 10-3 in the Appendix. Every thousands of barrels increase in production yields a US$ 0.953 increase in day rate[17]. The economic significance seems quite low, but keep in mind that that difference in oil production is great between countries – in 2013, the lowest registered production was 116,000 barrels and the highest 11,635,000 barrels. A potential explanation is that the demand for

[16] The positive correlation between GDP per capita and price level is often referred to as the Penn-effect. The effect that causes non-tradable goods to be relatively more expensive in rich countries is called the Balassa-Samuelson. These two effects are commonly used interchangeably. A more detailed description of the effects will be given in section 6 of this thesis.

[17] Or, potentially, the other way around. Unless the FE removes all correlation between the explanatory variable and the error term, I cannot conclude that a relationship is causal.

offshore services increases when oil production increases. Because supply in the short-term is relatively inelastic, this will cause an increase in prices.

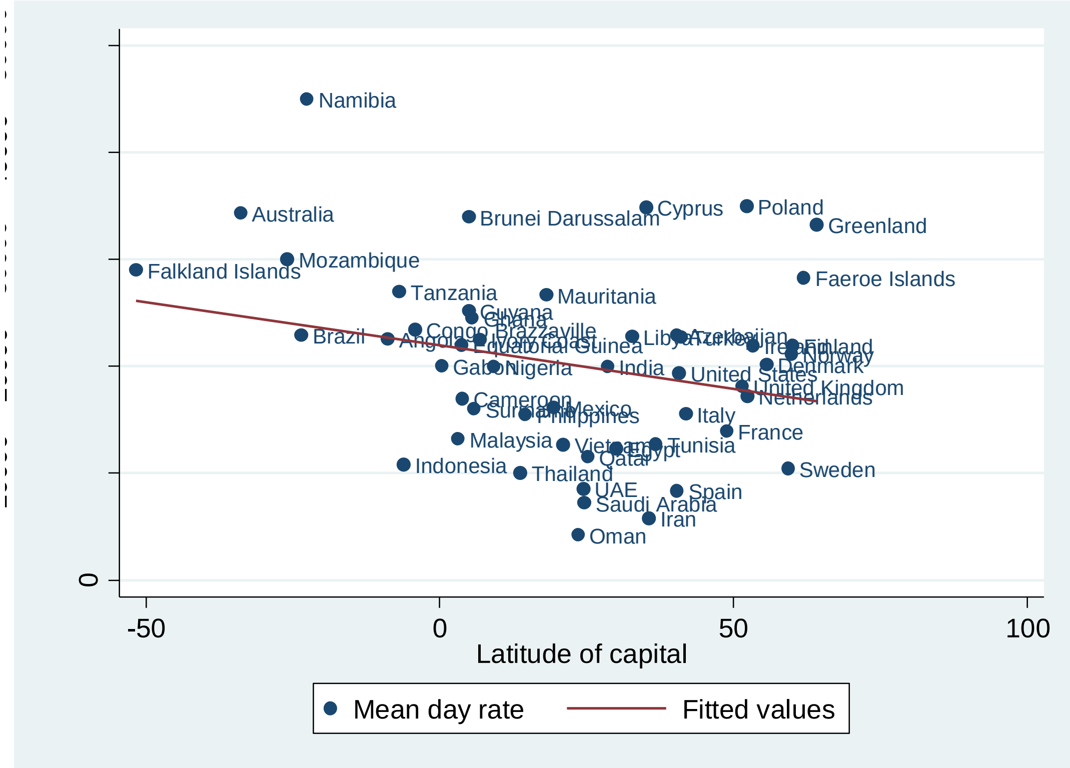
Alternatively, the positive correlation between high oil production and day rates adds to the hypothesis above, which connects a country's GDP per capita, price level and day rates. The result adds to this hypothesis in the sense that countries with high oil production are rich on black gold. Higher GDP per capita thus results in higher day rates, overlooking outliers such as Saudi Arabia. Whether institutional quality influence earned day rates through a country's GDP per capita will be further investigated in the next section.

Latitude holds constant the effect of geographical differences, such as climate. Because latitude south of Equator is negative, the interpretation of the coefficient is that everything else constant, the further south a country's capital is located, the higher the day rate. This supports the relationship displayed in Figure 5-2 (next page).

By adding the region Australia/New Zealand as explanatory variable, I control for the effects that the region have on a vessel's estimated earned day rate. The regression output is reported in the Appendix Table 10-5. Controlling for day rates observed in Australia/New Zealand does not alter the significant positive relationship between Polity and estimated earned day rates. However, earned day rate for a vessel in a country-year is significantly higher when the vessel is in the Australia/New Zealand region than when it is somewhere else in the world. The table also includes regression output when the regions Northwest Europe, South America and West Africa (respectively) are included in the model. Of the included regions, only Australia/New Zealand has significant influence on mean earned day rates when the effect of Polity score, latitude, median contract duration, oil production and year effects are held constant.

The practical interpretation of latitude is more complex. That day rates are higher in the South stands in opposition to a conventional economic postulation, which consider the poor "South" compared to the richer "North". If countries in the North indeed are richer, we should expect day rates to be higher the further North. In economic theory, this is called the Penn effect. According to the Penn effect, the price level is higher in countries with higher GDP per capita.

Figure 5-2 Mean day rates on the latitude of capital



A potential, although speculative, explanation of why day rates in the South are higher can be greater distances. Distances between operations, which leads to a higher day rate because of expensive mobilization/demobilization fees, and distances internally from the shore to the offshore installations. Both will reflect an increase in day rates due to higher operational costs.

The estimated coefficient of median contract duration implies that longer contracts have relatively lower day rates. A practical interpretation would be that if the charterer guarantees the owner a fixed income for a long period, the owner is willing to agree to a lower rate.

The conclusion from this section is that there is a significant and robust positive relationship between a country's Polity score and earned mean day rates in the corresponding country for a vessel in a given year. However, I cannot rule out that a negative relationship between Polity score and day rates exists. Here, if there indeed is a negative effect, the positive effect dominates the negative. Nonetheless, political risk may be still influence day rates indirectly. To investigate this further, the next section uses the instrumental variables approach to look at potential channels through which institutional works.

6. Polity as instrument

What is institutional quality? The Polity ranking measures institutional quality in terms of democracy. Democracy is a composite term; it is hardly achievable to give a brief, exact explanation of what a democratic institution is.

Using instrument variables is useful in two ways. One, it establishes a causal relationship between the independent and the dependent variable by removing all endogenous variation in the error term, and two, if the instrument is good, the instrumented variable is the only channel through which the instrument is correlated with outcome.

In the global society, everything is connected in some way or the other. The question here is not whether institutional quality does matter for day rates, but through which mechanisms. In this section, I will use Polity as instrument for a chosen set of variables, with the purpose of investigating through which channels institutional quality influences day rates. Whether the exclusion restriction holds is not a key concern here, because I am not trying to disclose a causal relationship between the instrumented variables and the dependent variable, but to see whether Polity is working through either of these channels. This application of IV might seem a bit unorthodox. In other words, the first-stage equations is the most interesting. I report the 2SLS estimator as well, but I do not spend too much time arguing whether this is the real causal effect on day rates or not.

I use GDP per capita, average risk against expropriation and legal formalism as potential channels for different reasons. How GDP per capita constitutes be an interesting channel is discussed below. The latter two are examples of unbundling institutions. Because institutional quality is a broad term, I want to see what type of institutions cause the Polity score to influence day rates.

6.1 Summary statistics

Day rate per vessel in a given country-year is the dependent variable. The model is the same as the one represented in baseline results, where the Polity variable is replaced by GDP per capita, average risk against expropriation and legal formalism, respectively. All standard errors are robust to heteroskedasticity.

Table 6-1 Summary statistics for instrumented variables

	Count	Mean	Min	Max	Std. Dev.
GDP per Capita (logarithmic scale) (World Bank)	3805	10.3	7.01	11.8	0.65
Average risk against expropriation	3782	9.18	4.68	10	1.17
Legal Formalism	3646	2.89	1.80	5.25	0.45

NOTE: The table shows summary statistics for the instrumented variables that is used in this section. GDP per capita is collected from the World Bank, and transformed to logarithmic scale Average risk against expropriation is measured on a ten point scale, where 0 indicates high expropriation risk and 10 low expropriation risk (good protection). This is a proxy for property rights institutions. Legal formalism is measured on a scale from 1 to 7, where higher legal formalism indicates more costly contracting processes between private parties.

6.2 Results and analysis

6.2.1 GDP per capita, current prices (logarithmic scale)

Academic research concludes that institutions are important for a country's economic development. A country's GDP per capita is a common measure for this. According to the Penn effect, the price level is higher in countries where GDP per capita is relatively high. Furthermore, the Balassa-Samuelson effect, which the Penn effect is often invoked to derive, says that in countries with a productive workforce, the real wage level will increase in all sectors and cause the relative price of non-tradable goods to increase. The correlation between GDP per capita and the Balassa-Samuelson effect is generally attributed to higher relative prices of non-tradables in wealthier economies[18].

With this in mind, may Polity score have a positive effect on rates because good institutions makes countries richer and therefore more expensive? According to the Penn effect, the day rates are higher because the price level is in general higher in richer countries. Because labor costs represents a large share of operating costs, the Balassa-Samuelson offers an additional

[18] For a theoretical derivation of "the equilibrium real exchange rate, the relative price of nontraded to traded goods", see Neary (1988). Neary writes on the Balassa-Samuelson effect: "Bela Balassa (1964) and Paul Samuelson (1964) argue that (...) deviations from purchasing power parity are to be expected because higher-income countries have higher relative productivity in the production of traded goods." Neary (1988) also explains how a boom in a resource sector may lead to a real appreciation, so-called Dutch Disease.

explanation, namely that day rates are higher in richer countries because of requirements to use of local workforce.

By using Polity as an instrument for GDP per capita, I will investigate if GDP per capita is a channel for though which Polity influence day rates.

Polity is a good instrument for GDP per capita only if Polity is exogonously given, that is, uncorrelated with the model error term, and if it relevant. The last criteria is met, as proved through the baseline results. Reasoning is the only way to defend whether GDP per capita is the only channel through which Polity is correlated with day rates, known as the exclusion restriction. This is not possible to test, because the error term is unobserved. The concept of institutional quality is very broad. The assumption of exogeneity is rather unrealistic, and whether this assumption holds is not the main focus here.

The error term contains factors that affect day rates and that are not controlled for. Some are unobserved, such as the ability of the crew, and some are omitted due to lack of data. Requirements to local content is considered to have impact on day rates. “Local content” usually refers to what share of local workforce the shipowner is obliged to use in the crew. Crew costs is one of the main operational costs for a shipowner, and if the local content requirements are high, the wage level of the offshore workers will be important for the day rate.

If Polity is indeed a good instrument for GDP per capita for measuring the causal effect on day rates, the 2SLS coefficient represents the more correct effect.

The first stage estimate show that Polity has significant, positive effect on GDP per capita. This corresponds well to the wide literature pointing at institutions as important for economic development. One unit increase in Polity induces 5.13% increase in nominal GDP per capita (or, potentially, the other way around). We can conclude that Polity is a relevant instrument. The “reduced form” is the direct effect of Polity on day rates. This is the same result as presented in as the baseline result.

Although it is hard to argue that Polity is completely exogenous, the regression output indicates that GDP per capita is indeed a channel through which institutional quality influence day rates. Using Polity as an instrument for GDP per capita, the 2SLS ratio indicates that GDP per capita has 4 times larger impact on day rates compared to the structural equation.

Table 6-2 Polity as instrument for GDP per capita.

	Structural	Reduced Form	First Stage	2SLS
GDP per capita (log)	2164.7*			7868.4**
	(975.1)			(2971.9)
Polity		336.8***	0.0513***	
		(100.8)	(0.0113)	
Dependent variable	Day rate (USD)	Day rate (USD)	Log GDP per cap	Day rate (USD)
Instrumental variable	-	-	-	Polity
Observations	2141	2141	2469	2141

Standard errors in parentheses
NOTE: The table shows the regression results in all stages of the IV method when Polity is used as instrument for GDP per capita (logarithmic scale). FE estimates. GDP per capita (logarithmic scale) is in current USD. Day rate is measured in nominal USD. Year dummies are included in the model. All regressions use the fixed-effects approach, following the model from the baseline results. Year dummies for the years 1995-2013 are included. Standard errors are heterogeneity-robust.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

That day rates are high in countries with good institutions because countries with good institutions in general are richer, and that requirements to local content causes operating costs to increase because of high wage levels in richer countries, is a valid explanation of the positive correlation between the average earned day rate in a given country-year and Polity score.

Although the result shows that GDP per capita is correlated with Polity, this does not clarify whether there exists a negative effect between institutional quality and day rates. Risk averse shipowners may still demand compensation for operating in areas considered less safe. Below, I will look into this by using Polity score as instrument for average protection against government expropriation. That way, we will see if political risk, which is a factor in this measure of property rights, is a channel for institutional quality to influence day rates.

6.2.2 Average protection against government expropriation

Acemoglu & Johnson (2005) use average protection against government expropriation as a proxy for property rights institutions. Property rights institutions relate to the relationship between the state and the citizens. The authors find strong support that countries with good property rights institutions have substantially higher long-term growth rates.

Again, Polity is a good instrument for average expropriation risk if Polity is relevant and exogenously given. Polity is related to expropriation protection in the way that a high Polity score is a sign of well-developed democratic institutions, and thus good property rights institutions. The first-stage regression estimates will show if the relevance criteria is met.

The reduced form equation is similar to the model in baseline results, which proves that a country's Polity score has direct impact on average day rates. The 2SLS estimate represents the true effect of GDP per capita on supply vessel day rates, presumed that both the relevance and exogenous criteria are satisfied. The regression outputs are presented in the table below.

The structural equation estimate indicates a significant positive relationship between average protection against expropriation risk and day rates. Better protection against expropriation by government indicates higher day rates. The economic significance is substantial, and counts 1,157.8 USD. The reduced form estimate is equal to the baseline result, showing Polity's direct influence on day rates. The first stage equation shows that Polity is a relevant instrument, as the relationship between Polity and the instrumented variable is significant. The coefficient interprets as for each unit increase in Polity score, the better the protection against expropriation.

Table 6-3 Polity as instrument for average protection against expropriation by government

	Structural	Reduced Form	First Stage	2SLS
Average risk against expropriation	1157.8**			1664.4***
	(395.4)			(483.0)
Polity		336.8***	0.220***	
		(100.8)	(0.0154)	
Dependent variable	Day rate (USD)	Day rate (USD)	Av. Expr. Prot.	Day rate (USD)
Instrumental variable	-	-	-	Polity
Observations	2140	2141	2465	2140

Standard errors in parentheses

NOTE: The table shows the regression results in all stages of the IV method when Polity is used as instrument for average risk against expropriation. FE estimates. Average risk against expropriation is measured on a ten point scale, where 0 indicates high expropriation risk and 10 low expropriation risk (good protection). Day rate is measured in nominal USD. Year dummies are included in the model. All regressions use the fixed-effects approach, following the model from the baseline results. Year dummies for the years 1995-2013 are included. Standard errors are heterogeneity-robust.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The 2SLS ratio suggests that the better property rights institutions in a country, the higher will the day rate level be, when vessel characteristics, geographical aspects, median contract duration, market demand measured by oil production and year effects are constant, and when the variation caused by a country's Polity score is eliminated. If property rights institutions is the only channel through which a country's Polity score influence day rates, the 2SLS estimate suggests a significant positive effect. Because good protection against expropriation is associated with institutions being of high quality, it is intuitive that property rights institutions influence day rates in the same direction as a country's Polity score.

Alternatively, the positive correlation between expropriation risk and day rates may be linked to vessel capital costs. Capital costs, or investment cost, is together with operating costs the main component of a vessel's cost structure. As mentioned previously, some counties require that vessels are built locally in order to be granted right to operate. Hence, the explanation as to why day rates are higher in countries with good property rights institutions might be that in these countries, investors are willing to invest more in the offshore supply market industry.

6.2.3 Legal formalism

Legal formalism is used as proxy for contracting institutions. Higher degree of legal formalism indicates more costly contracting processes between private parties. A lower legal formalism index value should intuitively be positive for day rates as this makes contracting between private parties less costly.

The structural equation estimate reveals that the degree of legal formalism has no significant effect on mean vessel day rates observed in a country-year. On the other hand, the first stage regression result displays a significant negative relationship between Polity and legal formalism. Better Polity score signifies a lower score on the legal formalism index and thus lower level of control intervention in the judicial process.

The relationship between institutional quality and contracting institutions is negative, which in this application means that better institutions yields less costly legal procedures. When Polity is used as instrument, the effect of legal formalism on day rates becomes negative. However, the relationship is not significantly different from zero. Using Polity as instrument for legal formalism when measuring the effect of legal formalism on PSV day rates yields no significant effects. As the structural equation shows, contracting institutions does not matter for the earned day rates in a country. Institutional quality as measured by a country's Polity score does not influence day rates through this type of institutions.

Table 6-4 Polity as instrument for legal formalism

	Structural	Reduced Form	First Stage	2SLS
Legal formalism	297.0			-3515.9
	(890.8)			(2029.4)
Polity		336.8***	-0.0997***	
		(100.8)	(0.0142)	
Dependent variable	Day rate (USD)	Day rate (USD)	Legal Formalism	Day rate (USD)
Instrumental variable	-	-	-	Polity
Observations	2101	2141	2410	2101

Standard errors in parentheses

NOTE: The table shows the regression results in all stages of the IV method when Polity is used as instrument for legal formalism. FE estimates. Legal formalism is measured on a scale from one to 7, where a higher score indicates a more costly legal procedure. Day rate is measured in nominal USD. Year dummies are included in the model. All regressions use the fixed-effects approach, following the model from the baseline results. Year dummies for the years 1995-2013 are included. Standard errors are heterogeneity-robust.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

7. Limitations and suggestions to further research

The market data used in this thesis are, as described by the providers, a tool to support private and public actors in decision-making processes. To the extent of my search for literature, I have not found published empirical studies based on the same data. A possible explanation is that access to these data is expensive. As a result, there have been no easy solutions or shortcuts throughout the process, and I have spent much time on data treatment and structure. That the data in general were challenging to access and use is no exaggeration.

In the process of structuring the data set, a few necessary adjustments were made. Out of a total of more than 10,000 observations of contract fixtures, 27 of these were so-called duplicates, where a vessel has registered the start of two different contracts on the same day. Because Stata needs a unique combination of panel and time variables, these duplicates were deleted. I count the impact of this on output as insignificant.

Another obstacle occurs with merging many different data sets. Thorough checks to see that everything merged correctly were made, but in a data set with many observations, errors due to unrecognized differences may have occurred.

In the literature survey, I cite two master theses. These are considered only as inspiration, and do not serve as basis for any of my research conclusions.

Cost drivers are important when analyzing prices. However, these are not always easily identified or accessible. I have used qualitative information from market players to help identify costs and factors that can possibly explain differences in market prices between countries. This, in combination with annual reports and lectures in offshore service markets at NHH serves as sources for identifying cost drivers. Some of the factors who are highlighted as main drivers are not easily accessed figures. The model includes data available within the scope of a master thesis. In developing the final model, I try to compensate for such weaknesses through the applied econometric techniques.

Throughout the thesis, I use the Polity IV score as measure for institutional quality. This is a composite index. Other measures for institutional quality might give other results. Therefore, the conclusion is not generic, and should be further challenged before one can confirm and describe the nature of the relationship between institutional quality and day rates for platform supply vessels with complete confidence.

Seeing the world as one entity is ambitious when trying to estimate a model. A more exact economic relationship might be easier to identify by splitting up in fewer regions, or compare two countries. Cost drivers are potentially easier to identify within a region, and a model on this basis would probably be more accurate. On the other hand, the aim of this thesis was not to estimate a predictive model.

A comment to the use of variables in section 6 ("Polity as instrument"): the wage level in the offshore sector need not be representative of the wage level in the country as a whole. A strong union might push the wage level up, in particular if the workforce is protected. Strict requirements to local workforce in the offshore sector is a way of workforce protection. According to the combined Penn and Balassa-Samuelson effect, countries with higher GDP per capita will also have higher wage levels. GDP per capita is therefore used as potential channel here, instead of the specific wage level of a country.

The estimated baseline model aims to disclose a significant correlation between a country's Polity score and vessel day rates. The model does not say whether the relationship is causal or not. Section 6 discusses a causal relationship between proxies for types of institutions and day rates, when Polity score is used as instrument for these proxies. Because I do not spend more time arguing whether the institutional quality score is exogenously given, i.e. that the exclusion restriction holds, I cannot conclude with a causal relationship.

Lastly, I analyze only one branch of the offshore supply vessel market. An interesting topic for further research would be to do a similar study of related markets, such as the offshore rig market. The thesis also focus on the role of crew cost and it would be interesting to collect data on crew cost in different countries and see if there is a relationship between crew cost, operating costs and institutional quality. Another parameter that would be interesting to look at is the tax legislation in the offshore industry around the world, and see if there is a significant relationship between day rates, institutional quality and tax rates.

8. Conclusion

There is a significant, robust positive correlation between institutional quality as measured by Polity score and earned average day rates for a PSV in that country in the corresponding year, when geographical aspects, market demand measured by a country's oil production, median contract duration and year effects are controlled for. Conclusively, the quality of a country's institutions as measured by the Polity IV score matters for day rates observed in the years 1995 – 2013.

By using Polity as instrument for GDP per capita, I aim to discover whether the positive relationship between Polity score and day rates is due to richer countries in general being more expensive. I find that GDP per capita has significant influence on day rates, and by using Polity score as instrument the influence is even greater. Thus, it seems that the correlation between GDP per capita and institutional quality serves as a possible explanation as to why a country's Polity score indeed has significant influence on day rates in the PSV market.

According to industry insiders, crew cost represents a substantial share of operating costs for shipowners. High wage levels combined with stringent requirements to local workforce is likely to result in higher OPEX and thus making a vessel more expensive to hire. Using the Balassa-Samuelson effect as argument, a country's GDP per capita serve as proxy for wage level. I find that GDP per capita have significant direct influence on day rates, and that by using Polity as instrument, the effect of GDP per capita on day rates is almost 4 times stronger.

The offshore supply industry is global, with the presence of competition across countries. Hypothetically, we would expect price and cost to equal across countries. However, to the extent there is a non-trivial amount of non-tradable inputs needed, we would expect that costs differ depending on the price differences of non-tradables. This is what seems to be the case here, where local requirements to input such as workforce drive costs up where this input is expensive.

"Institutions" is a broad term. By using proxies for the two type of institutions identified by Acemoglu & Johnson (2005) and using Polity as instrument for the two, I find that Polity influence day rates through property rights institutions, while contracting institutions as measured by degree of legal formalism does not matter for observed day rates.

The relationship between institutional quality and rates is ex ante ambiguous. A negative effect would be consistent with shipowners needing compensation to operate in countries with low quality institutions, e.g. due to high political risk. A positive effect, on the other hand, may be explained by higher costs in rich countries. The results presented in this thesis show that the latter seems to dominate. Furthermore, institutional quality seems to influence day rates through property rights institutions rather than contracting institutions.

The effect of institutions on economic development is a much researched and debated issue. Consensus lies on institutions being fundamental for a country's economic performance. This thesis shows that institutional quality also influence prices in the global PSV market specifically. This gives us a window into operating costs in the related oil industry. That, however, is material for further research.

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10. Appendix

Variables

Day rate measured in nominal USD

The day rate is the dependent variable in the model. The day rate is calculated as the mean day rate for each vessel earned a given country in a given year. The rate is measured in nominal US dollars. Year dummies will take into account inflation and changes in the global economy.

Polity

This is the explanatory variable of interest. I aim to estimate the relationship between Polity and average day rates obtained by a vessel in a given country.

Latitude of capital in degrees

I am interested in explaining a how a country's relative polity-score affects the day rate independent of where on the planet the vessel is operating. Geographical aspects such as currents, climate and weather conditions controlled for by adding the latitude of the country's capital.

Median contract duration

Spot and term are the existing market categories for contracts. A spot contract is defined as a contract with duration of 30 days or less. A risk averse operator will prefer longer contracts, to avoid the ship being laid-up in case of spot market excess capacity and low spot market day rates. On the other hand, if times are good and spot prices increase, the operator will miss potential revenue due to having his vessels fixed in long-term contracts. The volatile spot market rates will sometimes be higher and sometimes lower than long-term contract fixtures.

It is tough claim to say that duration is *always* decided first and day rate second, especially for long-term charters. However, I choose to overlook this potential causality issue.

Oil Production (1000 barrels/day)

A PSVs main task is to supply the offshore oil activity. A reported high oil production implicates higher demand for offshore services. Oil companies' exploration and production expenditures (E&P) is a common indicator for market activity. Due to data limitations, oil production in thousand barrels/day serves as measure for demand of offshore services.

Deadweight tons

This is a measure of a vessel's total freight capacity.

Break Horsepower

This measure the vessel's engine capacity.

Vessel age

Vessel age is the vessel's age measured in number of years since the vessel entered service.

Build cost (nominal USD, millions)

A vessel's build cost is the price that was paid for building the vessel.

Year Dummies, 1995 - 2013

This dummy variable captures the year effect. The coefficients interprets as the effect on day rate given a particular year in reference to the base year, which is 1995. Year dummies controls for both observed and unobserved variation between years, like changes in the global economy and related factors.

Table 10-1 Number of observations by country

Country	Number of observations
Angola	16
Australia	4
Azerbaijan	3
Brazil	225
Congo Brazzaville	10
Denmark	73
Egypt	6
Equatorial Guinea	1
Gabon	1
India	13
Indonesia	4
Iran	4
Italy	3
Libya	4
Malaysia	8
Mexico	65
Nigeria	16
Norway	648
Oman	1
Qatar	9
Saudi Arabia	7
Thailand	3
Tunisia	1
UAE	3
United Kingdom	1141
United States	197
Vietnam	3
Total	2469

NOTE: The table shows the number of observations by country that is included in the main model regression.

Table 10-2 Number of observations by year

Year	Number of observations
1995	58
1996	65
1997	43
1998	66
1999	84
2000	62
2001	38
2002	57
2003	98
2004	112
2005	142
2006	112
2007	133
2008	158
2009	189
2010	223
2011	293
2012	270
2013	266
Total	2469

NOTE: The table shows the number of observations by year included in the regression on the main model.

Figure 10-1 Distribution of dependent variable (day rate)

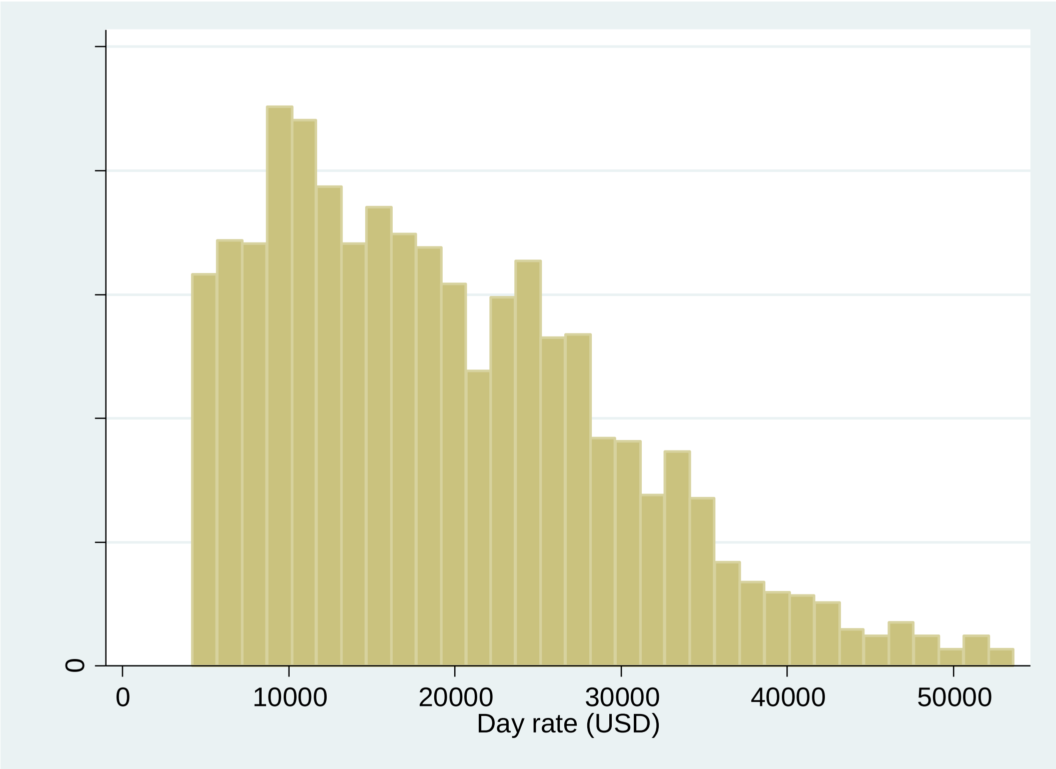

Figure 10-2 Development in global average day rates vs. UK and Norway

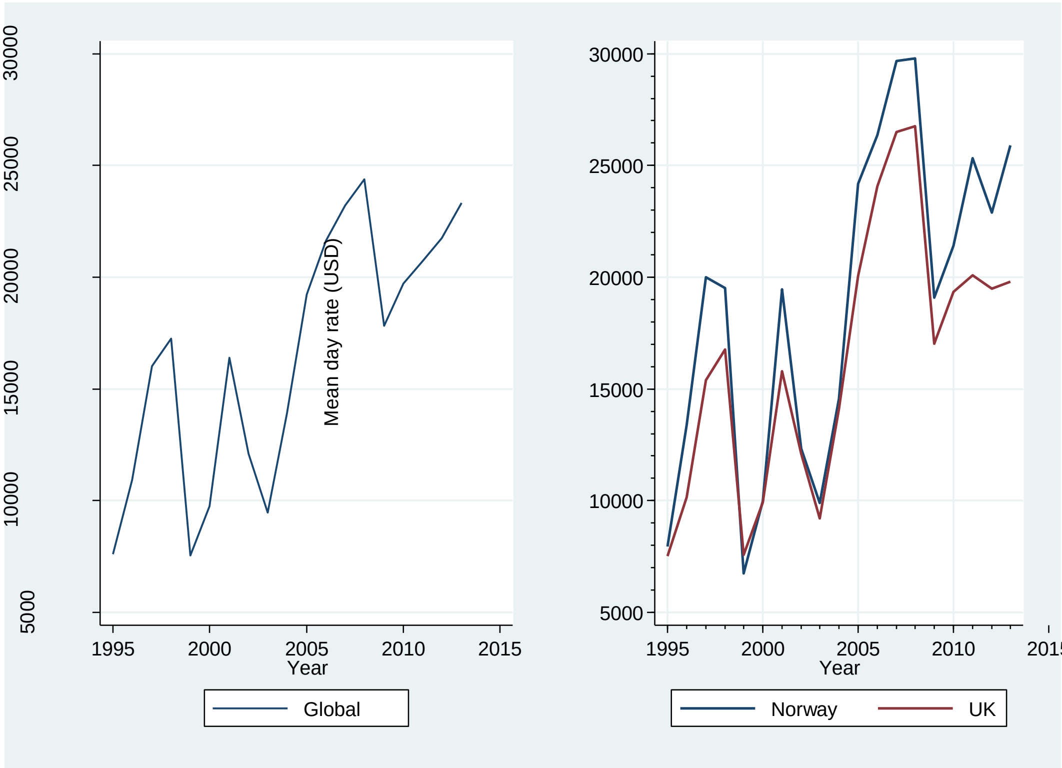

Table 10-3 Baseline results with year dummies

	(1) FE, main model	(2) OLS, main model	(3) OLS, expanded model	(4) FE, OLS expanded model sample
Polity	336.8**	372.6***	224.1**	137.3
	(108.9)	(61.58)	(71.88)	(87.69)
Latitude in degrees	-95.62***	-38.59***	-94.26***	-110.0***
	(15.87)	(9.913)	(10.84)	(19.15)
Oil production (1000 barrels/day)	0.953***	-0.871***	-0.686***	0.312
	(0.274)	(0.110)	(0.162)	(0.414)
Median contract duration	-2.211***	1.864***	-0.367	-1.907**
	(0.486)	(0.428)	(0.397)	(0.618)
DWT			2.205***	
			(0.474)	
BHP			0.467**	
			(0.172)	
Vessel age			-288.8***	
			(51.37)	
Buildcost (MUSD)			-46.21	
			(32.69)	
Year=1995	0			0
	(.)			(.)
Year=1996	2353.6*			-3865.4
	(974.5)			(3182.2)
Year=1997	8081.6***			1579.2
	(1384.5)			(2443.4)
Year=1998	9111.3***			4700.7**
	(1079.7)			(1440.4)
Year=1999	-2741.9**			-8308.8***
	(862.9)			(928.4)
Year=2000	560.6			-5948.4***
	(1095.8)			(985.6)

Year=2001	7634.9***			901.7
	(1412.3)			(2047.7)
Year=2002	966.7			-6313.3***
	(1165.1)			(1541.4)
Year=2003	-790.2			-7311.9***
	(1089.6)			(1029.7)
Year=2004	2763.0			-3878.0***
	(1409.2)			(1080.8)
Year=2005	10781.4***			3680.5**
	(1396.9)			(1233.3)
Year=2006	16693.5***			9194.0***
	(1779.7)			(1843.2)
Year=2007	19669.3***			10886.9***
	(1722.3)			(1841.9)
Year=2008	18670.5***			13016.2***
	(1486.5)			(1592.2)
Year=2009	6527.5***			1128.3
	(1327.4)			(1258.6)
Year=2010	10206.9***			4542.7**
	(1387.0)			(1599.6)
Year=2011	12154.6***			6676.8***
	(1362.9)			(1565.0)
Year=2012	10794.9***			4537.5**
	(1333.9)			(1577.1)
Year=2013	13346.2***			6615.6***
	(1354.9)			(1622.8)
Constant	8926.4***	19275.3***	16927.6***	20830.7***
	(1799.4)	(794.8)	(1554.5)	(1842.3)
Dependent variable	Mean day rate		Mean day rate	Mean day rate
Observations	2469	2469	1125	1125
R-sq.	0.370	0.0500	0.167	0.360

Standard errors in parentheses

NOTE: This table shows all estimated coefficients of the baseline model. Year 1995 is omitted because this is the reference year.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 10-4 Robustness checks of main results

	(1) Day rate (USD)	(2) Day rate (USD)	(3) Day rate (USD)	(4) Day rate (USD)	(5) Day rate (USD)	(6) Day rate (USD)	(7) Day rate (USD)
Polity	336.8**	-125.6*	117.3	223.8***	336.8***	336.8***	296.2**
	(120.7)	(62.94)	(66.71)	(67.61)	(100.8)	(100.8)	(102.0)
Latitude in degrees	-95.62***			-41.98***	-95.62***	-95.62***	-93.44***
	(17.90)			(9.371)	(15.74)	(15.74)	(15.91)
Oil production (1000 barrels/day)	0.953*				0.953***	0.953***	1.120***
	(0.412)				(0.266)	(0.266)	(0.273)
Median contract duration	-2.211***				-2.211***	-2.211***	-2.192***
	(0.606)				(0.509)	(0.509)	(0.509)
Crude oil, Brent ($/bbl, nominal$)						145.4***	
						(12.22)	
Term Utilization rate (%)							913.9
							(1500.1)
Year dummies included	Yes	No	Yes	Yes	Yes	Yes	Yes
Standard Errors	Clustered	Robust	Robust	Robust	Robust	Robust	Robust
Observations	2141	3692	3692	3692	2141	2141	2139
R-sq.	0.0280	0.00101	0.242	0.247	0.370	0.370	0.372

Standard errors in parentheses

NOTE: The table shows the regression output for robustness checks of the main model. The reported R-squared in model (1) is very low because the year dummies are partialled out. The year dummies are so-called singleton dummies, i.e., a variable with one 1 and N-1 zeros or vice versa. By clustering, I request a robust covariance matrix. The singleton dummy causes the robust covariance matrix estimator to be less than full rank. In this case, partialling-out the variable with the singleton dummy, here that is the year dummies, solves the problem. The R-squared of model (1) does not have a practical meaning.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 10-5 Baseline model with region controls

	Day rate (USD)	Day rate (USD)	Day rate (USD)	Day rate (USD)
Polity	281.8*	478.8**	202.6	296.8*
	(110.8)	(150.4)	(145.4)	(139.4)
Latitude in degrees	-90.76***	-49.33	-54.29	-95.30***
	(15.80)	(30.69)	(43.45)	(16.04)
Median contract duration	-2.121***	-2.371***	-2.328***	-2.199***
	(0.485)	(0.511)	(0.496)	(0.492)
Oil production (1000 barrels/day)	1.078***	0.911**	0.938***	1.071***
	(0.270)	(0.291)	(0.277)	(0.270)
region==Australia/New Zealand	7794.6*			
	(3524.9)			
region==Northwest Europe		-4472.4		
		(2664.3)		
region==South America			3696.7	
			(3200.4)	
region==West Africa				-144.7
				(2129.9)
Observations	2469	2469	2469	2469
R^2	0.372	0.373	0.372	0.371

Standard errors in parentheses

NOTE: The table shows estimates from the baseline model with region controls added. Year dummies are included in the regression, but not reported.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 10-3 Mean day rate on average oil production