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Price Premiums in the Shipbuilding Market

A study of determinants for bulker, tanker and container segments in the 1990-2014 period

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Abstract

In this thesis we investigate whether a number of variables specific to a vessel, the contracting parties, or market conditions affect the price charged for the ship. Literature in maritime economics seems to suggest that competitive shipbuilders are price takers, and thus have little influence on the prices they charge ship owners. However, deviations in price for comparable vessels contracted in the same period are observed.

Determinants derived from contract information and market conditions make up the covariates of the study, and we are particularly interested in the effects of delivery time, shipyard experience and firm size. The data sample contains contract information on 3,759 individual ships constructed at 77 shipyards between 1990 and 2014. We perform separate fixed effects regressions on the shipbuilding segments of bulk, container and tanker vessels, in order to incorporate shipyard and ship owner heterogeneity as well as capture segment specific effects. The results suggest that macroeconomic determinants are the most influential covariates, although we also find the microeconomic determinants gross tonnage, top speed, delivery time, as well as ship owner and shipyard heterogeneity affecting prices. The effects from these covariates prove to have different effects in the three segments. Similar for all markets is that ship owner fixed effects have a greater influence on price movements than those of shipyards.

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1. Introduction

The shipbuilding market is a truly global industry, with about 30 countries having a significant production of merchant vessels. Most of these shipbuilding nations are located in Asia or Europe, but the rest of the world is also present in the market (Stopford, 2009). Hundreds of commercial shipyards exist – in fact, the Community of European Shipyards' Association (CESA) alone represent over 300 shipyards in Europe (CESA, 2011).

On the buyers' side, ship owners are counted in thousands, operating tens of thousands of vessels. This dispersed ownership is, among other things, often credited to the lack of economies of scale at the firm level in shipping. The small gain that is possible to obtain from size can be achieved by other means than market consolidation - such as joining a pool of smaller companies, or outsourcing ship management to specialized management companies (Stopford, 2009). This market characteristic discourages mergers and acquisitions, as the potential return is limited.

When ship owners want to invest in new vessels, the most common practice is to contact several yards, and invite them to tender for the vessels in question. As the bids are received, the ship owner is free to choose the yard it sees as most competitive. In the event of a seller's market, where shipyard capacity is scarce, a normal tendering process might not be possible – in such an event, the shipyards can drive up prices, and insist on selling standard vessels to utilize economies of scale at the shipyard.

Many customers, many producers and open information are among the market conditions that need to be present in order to achieve perfect competition, which according to traditional theory eventually will drive prices down to marginal costs. These conditions seem to be more or less fulfilled under normal conditions in the shipbuilding market. Furthermore, there are very few trade barriers, and distance between the buyer and producer is not an issue due to the global nature of the shipping market. Another important prerequisite, however, is homogenous products. This is obviously not the case for shipbuilding, as two types of ships are not the same. Despite the products not being homogenous, one could argue that shipyard capacity is, as shipyards are capable of producing many different types of ships. Shipbuilders are in other words offering capacity, rather than ships, following such a line of thought.

Because the characteristics of the shipbuilding market indicate that it is close to the "perfect competition" end of the competition spectrum, one would expect that shipyards under normal circumstances at least would be price takers – if not having prices close to their marginal costs. What's more, "The Law of One Price" postulates that all arbitrage eventually will be eliminated. In practice this means there can be no gain in buying a ship from one particular provider rather than another, as all shipyards will need to charge the same price for a given vessel in order to remain competitive and, ultimately, in business.

The actual prices obtained by shipyards are however not in line with what one would expect from economic theory. There are significant deviations in the prices different shipyards achieve for the ships they build, even within the same type of ship in the same period[1]. This fact raises the question of whether shipyards can achieve price premiums, or need to give discounts, for various reasons.

1.1 Contribution of Our Study

Our study will contribute to the shipping and maritime literature in general, and the shipbuilding literature in particular. The aim of the thesis is to conduct what to our knowledge will be the first empirical study of microeconomic determinants in the shipbuilding market. This will be done by answering three questions, the first of which is whether delivery time of a vessel is affecting the price paid – assuming a shorter delivery time gives the owner revenue earlier. Second, whether the experience of the shipyard plays a role in the price setting. Experienced yards could possibly be able to price higher, because of increased certainty of delivery and perceived quality, while so-called greenfield yards might have to undercut the competition in order to secure work in tight markets. Lastly, we investigate whether the size of either the ship-owning firm or the shipyard has any influence on price, assuming either party could leverage bargaining power. To our knowledge, none of the questions have been investigated explicitly in a quantitative manner in existing literature. Because the shipbuilding market is believed to be one of the world's most open and competitive markets (Stopford, 2009), it seems that little research has been directed at the shipbuilder or ship owner's ability to affect the price of newbuilds.

[1] Data for vessels from Clarksons Research's World Fleet Register, which will be introduced later, is one source of proof for such discrepancies.

2. Literature Review

2.1 Competition in the Shipbuilding Market

There seems to be a consensus in the shipbuilding literature that the shipbuilding market indeed is one of the most open and competitive markets in the world, with several authors making such a claim (Stopford, 2009, Alizadeh and Nomikos, 2009, Bertram, 2003). Many reasons are provided for this; among these is the fact that multiple yards are invited to tender for a particular vessel, there are very few regulatory trade barriers, and a large numbers of players exist on both the buyer and seller side (Stopford, 2009)

In his doctoral dissertation, Sauerhoff (2014) researched whether a number of shipyard specific resources affected “Being Competent in the Field of Service”, and ultimately whether that variable would increase a shipyard’s ability to secure orders. “Service” is here defined as a form of intangible characteristic related to the end product or the production process, such as a fuel-saving hull design. The variables the author found to have a statistically significant impact on “Being Competent in the Field of Service” were practical experience, market expertise, cooperation with suppliers and external exchange of information. Lastly, competency in services had a significant impact on the shipyards’ competitiveness. The dissertation provides evidence that differentiation among shipyards both happens, and is an important element in the competition in the shipbuilding industry. Differentiation is of course counter to perfect competition, and this result therefore indicates that the market is not perfectly competitive. Stott (1995) conducts a similar investigation, and finds that a number of attributes related to a vessel, such as ease of maintenance and operation, fuel consumption, speed, safety and delivery conditions had a positive impact on the probability of attracting orders for the shipbuilder. The ship owners were however reluctant to pay a significant premium for such features.

Jiang, Bastiansen and Strandenes (2013) state that shipyard competitiveness often is assessed based on internal factors, such as costs. Shipbuilding however, is very exposed to its external environment they argue, in particular general market conditions and governmental interference. The authors introduce profit-rate as a means of measuring competitiveness, and thus account for both internal and external factors. By this measure, the authors find that China is the most competitive shipbuilding nation in the tanker and bulker markets, ahead of its main competitors South Korea and Japan. When looking at the specific nations, the authors find that China's competitiveness stems from their cost base. South Korea and Japan has theirs derived from a positive deviation from the market price – implying that the state of perfect competition is not achieved in the market. General market conditions, expressed through the market price, are affecting all three countries. The current time charter rate is also significantly affecting the competitiveness of China and South Korea, but not Japan – something the authors give the larger domestic Japanese market credit for.

Jiang and Strandenes (2011) examine the relative competitiveness of Chinese shipbuilding, to that of its main competitors South Korea and Japan. The authors examine the three main components of shipbuilding costs - labour, steel and equipment – and find that China from a cost perspective is the most competitive nation, ahead of Japan and South Korea respectively. Combining both wages and labour productivity, the authors conclude that labour unit costs are lowest in China, followed by Japan and South Korea. Steel prices are relatively similar, but with a slight cost advantage for China. Equipment is most expensive in South Korea, with China once again being the cost leader. While market share, or size of the shipyards or shipbuilding nations, is not claimed to be a competitive advantage, it serves as an indicator of competitiveness – assuming competitive shipbuilders will grow their market share over time. Combining costs and market share in a 2x2 matrix, the paper ultimately determines whether the nations are emerging (China), growing, maturing (South Korea) or declining (Japan).

Whether there is one large or multiple separate newbuilding markets is investigated by Wijnolst et al. (2009). According to them, there is a single market if either the vessels or the yard capacity is homogenous. The former is obviously not the case, because individual types of ships are very different. One form of evidence for the latter is found when comparing the number of fast ferries constructed, to the number of shipyards active in this segment. Fast ferries are assumed to be an advanced type of product, where the technological development is rapid. Because the number of active yards is proportional to the number of orders, and because this happens without any time lag, the authors conclude that technological transfer happens fast and that shipyard capacity is flexible. Haddal and Knudsen (1996) investigate correlations between newbuilding prices for various ship types, and find that most vessel types have their prices closely correlated to those of the other types – while all vessel types have an average correlation coefficient above 0.7.

2.2 Prices in the Shipbuilding Market

Ship owners interact with four distinct and different markets merely by being in the business of ship operation. These are the markets for freight, newbuilding, second-hand vessels and demolition – three of which are related to acquisition and disposal of the ships themselves. These markets are closely integrated, and the actions and sentiment in one of them will ripple through to the other three (Stopford, 2009).

Much research has been dedicated to better understand the nature of the relationship between the newbuilding and second-hand markets in particular. The idea of linking these markets through net present value appears to be introduced through Strandenes (1984) and Beenstock (1985). In the latter paper, it is assumed that the price of a new vessel perfectly reflects the second-hand price of a comparable ship at the time of delivery. This model is applied to the dry cargo market in Beenstock and Vergottis (1989), but the strict assumption of perfect correlation between new and second-hand prices is moderated as these prices, among other variables, are determined jointly and dynamically. Strandenes (1984) finds that the price of a second-hand ship must be equal to the present value of the ship's earnings. In later work (Strandenes, 1986) it is deduced that newbuilding prices will be set based on the expected present value of future earnings, while second-hand prices are given by the weighted average of short and long term profits. Tsolakis et al. (2003) concludes that the main drivers for second-hand prices are the newbuilding price and time charter rates, although these variables are affecting distinct vessel types and sizes differently. Through a Vector Error Correction Model framework, Adland et al. (2006) test the equilibrium relationship between newbuilding prices, second-hand prices and freight rates in the 2003-2005 period in the dry bulk market, and find that the second-hand market was closely co-integrated with the newbuilding and freight markets.

Ever since Zannetos (1966) it has been suggested that newbuilding prices are sub-optimal, resulting in a destabilizing effect in both the shipping and shipbuilding markets. One would expect that when time charter rates are high, and increased ship contracting is induced, shipyards would quote higher prices and thus balance the market. This is however not what is observed. While newbuilding prices indeed are very volatile, they are less so than time charter rates would suggest, and price changes seems to be slower than expected.

Zannetos argued that this was due to market imperfections and externalities, such as over-capacity and production smoothing incentives. This view is shared by Strandenes (2010) who argues that one of the causes is strong labour unions in shipbuilding, which among other things has made shipbuilding nations compete to protect their own yards through various forms of subsidies. In fact, the author claims competition between shipbuilding nations often is more influential than competition between shipyards.

The Zannetos-Strandenes explanation for this effect is challenged by Dikos (2004). In this paper the author suggests that prices of new vessels will drop to the marginal costs of the marginal supplier (often Japan), because of the industry's aggregate marginal cost function. Furthermore, Dikos argues that increased prices will cause shipyards with slightly higher marginal costs to start bidding and become competitive. Because the already competitive shipyards anticipate this to happen, an upper barrier to vessel prices is imposed – an effect that accounts for the lower than expected volatility. Adland and Jia (2015) propose a different approach to this problem, where they argue that a second-hand ship and a newbuild merely differ in time until it can generate revenue - if one ignores technical differences. Through an equation relating prices in the four shipping markets, they show the existence of a term-structure in the newbuilding market implying that prices are not comparable over time, due to changing payment schedules and delivery lag. Accounting for this and the alternative cost related to operation, they show that the price of a newbuild can be viewed as a futures contract, which implies lower volatility.

According to Stopford (2009), newbuilding prices are set by the number of slots available at shipyards in a given timeframe, and the number of vessels demanded in the same period. If potential orders outnumber the available slots, prices will be driven upwards until enough ship owners drop their orders, and there is a match between the number of slots and orders. Vice versa, if slots outnumber potential orders, prices will drop until a new equilibrium is reached. Prices are thus ultimately determined by factors affecting the number of slots and potential orders. If newbuilding prices are given, demand is influenced by freight rates, prices for second-hand vessels, market sentiment, availability of credit and liquidity. Supply on the other hand is affected by current capacity, shipyard costs, exchange rates and government subsidies.

For a 30,000 dwt bulk carrier at a competitive yard, Stopford (2009) finds that 53 percent of the costs are related to materials or items and services purchased by the yard, while 47 percent is related to labour and overheads. Although many of the important and expensive items, such as the main engine, are manufactured by large and international firms, this often happens near the global shipbuilding hubs – giving a slight cost and logistical advantage to the large shipbuilding nations. In addition to equipment, steel is a significant cost driver accounting for 17 percent of the costs. Labour costs are determined by a combination of labour unit costs and productivity, making it possible for countries with both high wages and productivity to compete for orders.

Wijnolst et al. (2009) discuss the effects of currency exchange rates on newbuilding prices. Because most capacity is located in China, Japan and South Korea, and there is a lead-time on capacity expansion, short-term fluctuations in these three currencies can have an enormous effect on ship prices they conclude.

3. Methodology

In this chapter, we present the methodology of our study. The work of Wooldridge (2013) on ordinary least squares (OLS) multiple regression models forms the basis for this study. We use OLS multiple regression to evaluate and explain the value of one dependent variable, based on a set of independent variables. The multiple regression model allows us to control for several factors that simultaneously affect the dependent variable U. As we add more variables that are useful to describe U in the model, more of variation in the predicted variable can be explained. The general multiple linear regression model is illustrated in equation (1), where β_0 is the constant value, $\beta_1, \ldots, \beta_k$ are isolated coefficient effects of independent variables on the predicted U, ε is the error term, i represents the entities, k is the number of independent variables, and t represents periods in time.

(1) $U_i = \beta_0 + \beta_1 GT_i + \beta_2 D_i + \cdots + \beta_k x_{i,t} + \varepsilon_i$

Fixed and Random Effects Estimators

When analysing a data set carrying repeated interactions of entities, in our case the shipyards and ship owners, fixed- or random effects models are suited tools. Fixed effects models allow for correlation between ε and $x_{k,it}$, while random effects models do not (Wooldridge, 2013, p.477). Fixed effects allow estimates to account for heterogeneity, as it adjusts for time-invariant unobserved effects that vary across entities, and/or constant time-varying effects across entities. Equations (2) to (4) show specifications including fixed effects. On the other hand, random effects models treat time-invariant observable and unobservable characteristics as a part of disturbances (ε), assuming correlation between characteristics and the independent variables to be zero.

In order to determine which of the approaches to apply, a specification test developed by Hausman is recommended (Wooldridge, 2013, p.478). It tests the covariance between independent variables and ε, with the hypothesis of random and fixed effects estimates being so close that it does not matter which one is used. The random effects model is preferred when the hypothesis holds up. A rejection of the Hausman test, illustrated in table 3-1, proves that the assumption is false due to covariance between ε and the independent variables. Hence, the fixed effects model is preferred for this study.

Coefficients	(b) Fixed	(B) Random	(b-B) Difference	sqrt(diag(V b-V B)) S.E.
GT	0.00173	0.0000785	0.00165	0.000508
Speed	-1.958	103.7	-105.7	16.89
Delivery time	0.301	0.530	-0.230	0.0204
Yard Experience	-7.537	-0.571	-6.966	2.290

b = Consistent under Ho and Ha
B = Inconsistent under Ha, efficient under Ho
chi2(3) = 140.70
Prob>chi2 = 0.000

Table 3-1: Hausman-test for fixed vs. random effects regressions

Econometric Approach

We adapt this approach to the newbuilding market, by using the newbuilding price U given in USD per CGT as our dependent variable. We explain newbuilding prices as a linear function of gross tonnage (GT), delivery time, yard experience, yard size, owner size, owner and shipyard fixed effects, and macroeconomic variables. In our study, we exclude the time-varying aspect, as we introduce macroeconomic variables to correct for time effects. All regressions is done with a clustered sandwich estimator[2], to correct standard errors, and avoid autocorrelation and heteroscedasticity when introducing fixed effects (Cameron and Miller, 2015). As we include dummy variables in our specifications, we need to exclude at least one dummy variable per set in order to avoid perfect multicollinearity – the so-called dummy variable trap (Wooldridge, 2013, p.841).

We propose three specifications to measure explanatory effects of the independent variables. First (2), we do a regression without other firm related variables than size, secondly (3) we correct for shipyard fixed effects, and lastly (4) a two-way fixed effects regression including both owner and shipyard fixed effects (i.e. superior market information or ability to bargain). We expect unobservable and observable characteristics of ship owners and shipyards to be rather constant over time, at least for firms appearing frequently. In specification (2), we illustrate the first microeconomic specification; GT_i is a vessels' gross tonnage, D_i is the delivery time, E_i is a measure of yard experience, $Y_{i,y}$ is the dummy variables for shipyard size, $O_{i,o}$ is the dummy variables for owner size, and θ represents the coefficients of dummy size variables.

(2) $U = \beta_0 + \beta_1 GT_i + \beta_2 D_i + \beta_3 E_i + \sum_y \theta_k Y_{i,y} + \sum_o \theta_k O_{i,o} + \varepsilon_i$

[2] Huber-White Sandwich estimator in STATA.

Owner and shipyard fixed-effects can account for firm characteristics, keeping coefficients from being biased up- or downwards, as when there is no control for owner or shipyard interactions. Repeated transactions for owners and shipyards allow us to account for observed or unobserved firm characteristics. In (3), we control for shipyard characteristics, excluding yard size, as this is rather constant and explained by yard fixed-effects. The γ represents fixed-effect coefficients, while δ is dummy variables generated for respective yards and owners

(3) $U = \beta_0 + \beta_1 GT_i + \beta_2 D_i + \beta_3 E_i + \sum_y \gamma_y \delta_y + \sum_o \theta_k O_{i,o} + \varepsilon_i$

In (4), we have a two-way fixed effect model controlling for both shipyard and owner fixed-effects.

(4) $U = \beta_0 + \beta_1 GT_i + \beta_2 D_i + \beta_3 E_i + \sum_y \gamma_y \delta_y + \sum_o \gamma_o \delta_o + \varepsilon_i$

As we want to isolate firm fixed effects, we introduce a second specification set including macroeconomic variables to control for time-varying effects, which yards or owners are unable to influence. First (5), we control for firm sizes, secondly (6), we introduce shipyard fixed effects, and thirdly (7), we include yard and owner fixed effects. We introduce an interaction variable between delivery time and freight rates, with τ being coefficient and F representing dummies for low, medium or high freight rate level. Other than this, specifications (5-7) includes; I representing competitive market price for average ships, S representing steel prices, P is the oil price, while G is the shipyard nations' GDP per capita.

(5) $U = \beta_0 + \beta_1 GT_i + \beta_2 D_i + \beta_3 E_i + \beta_4 I_t + \beta_5 S_t + \beta_6 P_t + \beta_7 G_t + \sum_f \tau_k F_{i,f} + \sum_f \tau_k F_{i,f} * D_i + \sum_y \theta_j Y_{i,y} + \sum_o \theta_j O_{i,o} + \varepsilon_i$

(6) $U = \beta_0 + \beta_1 GT_i + \cdots . + \beta_7 G_t + \sum_f \tau_f F_{i,f} + \sum_f \tau_f F_{i,f} * D_i + \sum_y \gamma_y \delta_y + \sum_o \theta_j O_{i,o} + \varepsilon_i$

(7) $U = \beta_0 + \beta_1 GT_i + \cdots . + \beta_7 G_t + \sum_f \tau_f F_{i,f} + \sum_f \tau_f F_{i,f} * D_i + \sum_y \gamma_y \delta_y + \sum_o \gamma_o \delta_o + \varepsilon_i$

We do not look at specific shipyard-owner relationships, as repeated relationships rarely occur in our sample and is unlikely to cause distinct effects.

4. Regression Variables

This chapter will define and discuss our dependent variable, as well as introduce the independent variables.

4.1 Dependent Variable

In order to investigate price deviations among vessels, the total contract price of each ship is divided by its Compensated Gross Tonnage (CGT) value. The CGT unit of measurement was introduced by OECD as an answer to the lack of a reliable indicator of the work amount required to build a ship. Two ships with the same Gross Tonnage or Deadweight Tonnage can vastly differ in work content, as these units merely measure size and carrying capacity. The CGT of a vessel is calculated based on the following formula, where A and B are factors specific to the various ship types (OECD, 2007).

$$Compensated\ Gross\ Tonnage = A * Gross\ Tonnage^{B}$$

In order for contract prices to be comparable, we inflate all numbers to 2014-levels and convert all currencies into USD based on the exchange rate at the contract date. Hence, we arrive at the following dependent variable for newbuilding prices.

$$USD\ per\ CGT = \frac{Inflated\ and\ currency\ exchange\ rate\ adjusted\ contract\ price}{CGT}$$

While CGT is widely accepted as the best unit of shipyard production (Bertram, 2003), it is not without flaws. Stopford (2009) points out that the CGT measure has decreasing value the more sophisticated or complex a ship is. Bertram (2003) makes a similar point when stating that differences in equipment can shift the number of required man-hours, while leaving the CGT-value unchanged. The CGT-value will assume a standard ship for each vessel category, while ships within the same category that deviates for instance in the form of more or less sophisticated equipment will have its CGT somewhat skewed. The reader is encouraged to keep this effect in mind when assessing the results of this study.

4.2 Independent Variables

This section provides an overview of independent variables and our predictions. We start by summarizing how we predict determinants to affect the dependent variable. Next, we discuss firm and contract specific variables, and ultimately macroeconomic factors that may affect the outcome of our analysis.

Variable	Predicted effect on USD/CGT
Firm Specific Variables:	
Ship Owner Size	Negative
Shipyard Size	Negative
Shipyard Experience	Positive
Contract Specific Variables:	
Delivery Time	Negative
Top Speed	Positive
Gross Tonnage	Positive
Macroeconomic Variables:	
Delivery Time * Freight Rate Interaction	Negative/Positive
Freight Rate	Positive
Newbuilding Price Index	Positive
GDP per Capita	Positive
Steel Price	Positive
Oil Price	Positive

Table 4-1: Predicted effects on USD/CGT from explanatory variables

4.2.1 Firm Specific Variables

Owner size

The Clarksons Research database categorizes ship owning firms by size, based on the number of vessels they control: Single ship, very small (2-5), small (6-10), medium (11-20), large (21-50), very large (51-100) and extra large (100+). Dummy variables are made for each category mentioned, in addition to one extra for firms of unknown size. Because the precise number of vessels under the ship owner's control is not observable, a continuous variable cannot be used to describe firm size. Do note that both shipyard and ship owner size is a snapshot at the time of contract signing, and the same firm can thus be several different sizes for different observations.

Traditional economic theory, like Porter (1979), postulates that buyers can affect the price they pay to their suppliers if the firm is of a certain size, or purchases in large volumes. These two criterions are likely to be highly correlated in the shipbuilding market, as larger ship owners are more likely to contract new vessels more frequently. The question is whether any of the owners are large enough to have a significant impact on price – something the maritime literature seems to suggest they are not.

Regardless of whether firms in this industry are large enough or not, it seems possible that given a certain size, some effect on the price will be observed. Hence, we propose a negative impact on price from owner size.

$$Owner\ size = Dummy\ variable\ for\ owner\ firm\ size$$

Shipyard size

The sizes of shipyards are categorized by Clarksons Research based on current order book in millions of CGT: Very small (< 0.049), small (0.049 < 0.01), medium (0.1 < 0.49), large (0.49 < 1) and mega (> 1). These groups make up our shipyard size dummy variables, in addition to one for yards of unknown size.

Just like for large buyers, Porter (1979) suggests that larger producers are able to influence the price. This is particularly true, Porter claims, if producers are more concentrated than buyers are, which obviously is the case for shipbuilding as ship owners outnumber shipbuilders. Larger shipyards could also potentially obtain higher prices as a result of the flexibility that comes with size. These yards are presumably capable of competing for even the largest vessels, while this might not be feasible for smaller yards. Hence, large shipbuilders are possibly operating in segments with fewer competitors, as well as having a greater variety of contracts to bid on. On the other hand, larger shipyards might be able to utilize economies of scale, pushing their costs down. This is notably the case if the shipbuilder receives several simultaneous orders for identical vessels (Stopford, 2009).

Whether yard size affects shipbuilding prices in a positive or negative manner, is thus dependent on which of these effects that is dominant. The literature suggests that no shipbuilder is large enough to have a superior bargaining position, while the effects of economies of scale seem well understood. Hence, we expect a negative relationship between the price obtained for a vessel and shipyard size.

$$Shipyard\ size = Dummy\ variable\ for\ shipyard\ firm\ size$$

Shipyard experience

All else equal, it must be reasonable for a ship owner to place its order with an experienced shipyard rather than a newly established one. This assumption is empirically supported by Sauerhoff (2014), who finds that practical experience indeed affects a shipyard's ability to secure contracts. If greenfield yards are likely to pop up during the boom part of the shipbuilding cycle when orders are plentiful, and struggle in the inevitable downturn afterwards, it seems reasonable that they must compensate somehow - possibly in the form of price discounts. A new variable is created by subtracting a shipyard's first year of delivery from the year a particular contract was signed, in order to capture the experience of the shipyard at the contract date. If the shipbuilder has not delivered any vessels at the time of contract signing, this equation will yield a negative value, which is a mere technicality due to how the variable is defined. Our hypothesis is that the experience of a shipbuilder has a positive impact on price.

$$Shipyard\ experience = Contract\ year - First\ year\ of delivery$$

4.2.2 Contract Specific Variables

Delivery time

A vessel with shorter delivery time will generate return on the investment earlier, hence having a higher value to the ship owner in present value terms than an equal vessel with longer delivery time (Adland et al., 2006, Adland and Jia, 2015). Stott (1995) finds at least partial evidence for this hypothesis, as shipbuilders with superior delivery times are more likely to attract orders. The effects on the prices are however rather ambiguous as the author concludes that ship owners are unwilling to pay a significant premium for such a feature. Full support is found by Bertram (2003) who states that differences in delivery times are likely to be captured in contract prices. The difference in months between delivery and contract date makes a new variable, describing the delivery time of individual vessels. We suggest a negative impact on price from delivery time.

$$Delivery\ time\ (months) = Built\ date -\ Contract\ date$$

Top Speed and Gross Tonnage

CGT is not a perfect measure of the work content in ships that are deviating from the complexity of the average ship in a certain category (Bertram, 2003). The top speed of a vessel in knots is therefore introduced as a proxy for complexity, based on the assumption that ships having higher top speeds are more sophisticated, and thus require a greater number of man hours to construct. We find no backing for this hypothesis in literature, but the fact that greater speed requires larger installed power, all else equal, appears obvious, and it is therefore our view that top speed at least to some extent captures differences in complexity. We expect a positive impact on price from top speed.

Another proxy for complexity and magnitude of the scope of work is introduced in the form of gross tonnage. This variable is a measure of physical size based on the internal volume of a ship. While there is no theoretical support found for the assumption that size (GT) and complexity are correlated, it is at least undeniable that man hours must be increasing in vessel size – all else equal. Hence, we propose a positive relationship between GT and price.

4.2.3 Macroeconomic Variables

Clarksons Research Newbuilding Price Index

Because the shipbuilding industry is so competitive (Stopford, 2009), and because it is so exposed to its external environment (Stott, 1995), the pricing of a newbuild is to a large extent outside the individual shipbuilder’s control. In order to properly control for the given market conditions and external environment, we introduce current estimated competitive market prices as an explanatory variable.

There is one monthly price on a USD/CGT basis for bulk carriers, fully cellular container vessels and tankers, which are matched with corresponding vessel types in the data set. This price is what one would expect to pay per CGT for a standard vessel at a top tier, competitive shipyard the current period (Clarksons, 2016a), and the index is thus more likely to be a good fit for vessels and yards that are similar to those assumed by Clarksons. The newbuilding price index is expected to capture the bulk of variability in price, considering that literature seems to suggest that very little pricing can be done by the shipyard. We expect a positive effect on the contracting price from the market price index.

$$Newbuilding\ price\ index = Monthly\ price\ for\ the\ three\ vessel\ groups$$

Delivery Time and Freight Rate Interaction

The value of shorter delivery time is a function of the freight rates the ship is able to obtain (Adland et al., 2006, Adland and Jia, 2015), and this aspect is controlled for by introducing an interaction variable between freight rates and delivery time. Freight rates are described through average time charter rates of one year duration for each of the vessel groups at the time of contract signing. Interacting two continuous variables will yield results that are hard to interpret as there are two dynamic parts, and hence no fixed variable to measure against. This effect is countered by making the continuous freight rate variable into a factor variable, where the values at or below the 33rd percentile make up our low freight rates scenario, values between the 33rd and 66th percentile make up our normal scenario and values above the 66th percentile make up the high freight rates scenario.

The value of early delivery is increasing in freight rates (Adland et al., 2006, Adland and Jia, 2015) and we therefore expect a negative impact on USD/CGT from the interaction variable in a high freight rate scenario. For low freight rates, in particular if the rates are lower than operating expenses, we expect to find a positive relationship between delivery time and USD per CGT.

$$Del.Time\ and\ Freight\ Rate\ Interaction = Del.Time * Freight\ Rate\ Factor\ Variable$$

In order to avoid specification errors in the model that might arise from leaving out variables included in an interaction variable (Wooldridge, 2013, p.191), freight rates and delivery time are incorporated as a stand-alone variables. The positive effect of freight rates on shipbuilding demand and prices seem well understood and obvious, as it is so crucial to the profitability of the shipyards' products and its customers (Strandenes, 2010, Stopford, 2009). Consequently, we propose a positive impact on the dependent variable from freight rates.

Gross Domestic Product per Capita

Costs are widely believed to be the single most important factor in determining the competitive position of a shipyard, and firms incapable of maintaining a sufficient cost position will be unable to secure contracts, as ship owners will go elsewhere (Bertram, 2003). Furthermore, nearly half of the costs incurred during the construction of a standardized bulk carrier are related to overheads and labour, according to Stopford (2009).

Obtaining reliable time series for wages is tricky, particularly for China, which is a dominant player in the industry. We therefore introduce GPD per capita as proxy for wages. ILO (2008) finds support for the use of this proxy when comparing 60 countries between 1995 and 2007, showing that each 1 percent increase in annual growth of GDP per capita is, on average, associated with a 0.75 percent increase in annual wage growth. Further empirical support is found by Rodrik (1999) who demonstrates significant effects from GDP per capita on wages. This variable will also to some extent capture other cost elements specific to the country of manufacture that are hard to include by other means. Because increased costs ultimately must be priced out to customers in order to survive, we propose a positive impact on price from GDP per capita.

Oil and Steel Price

Steel is the most important of all materials used in shipbuilding, amounting to 17 percent of total construction costs for a standardized bulker (Stopford, 2009). This cost element is captured by including the global price for hot rolled coil steel at the time of contract signing. While there are minor regional differences in the prices paid for steel (Jiang and Strandenes, 2011), these seem small enough to justify the use of a global price. We propose a positive impact on USD per CGT from the price of hot rolled coil steel.

Production consumes energy, which comes at a cost for the shipbuilder. In order to capture this element, we include oil prices as an explanatory variable. The included oil price variable is a basket containing the simple average of dated Brent, West Texas Intermediate and Dubai Fateh spot prices. While oil might or might not be directly consumed for energy production, it is the main driver for energy and electricity prices – primarily due to its influence on the prices of gas and coal (Department of Energy & Climate Change, 2012). Furthermore, the price of oil could potentially have a direct effect on the demand for vessels, in particular tankers used to transport this cargo. Hence, we expect a positive effect on prices from the price of oil.

4.3 Omitted Variables

Currency Exchange Rates

Nearly all shipbuilding contracts are quoted in USD, while the shipbuilders have most of their costs in local currency. Fluctuations in shipbuilding currencies consequently impacts shipbuilding prices, as the cost base of shipyards expressed in USD is affected (Wijnolst et al., 2009). Such fluctuations alter the relative competitiveness of shipbuilding nations, although the exact effect is determined by the share or amount of inputs denominated in USD, local or other currencies. If we were to create a variable for currency, it would be in the form of a basket of currencies in order to avoid grouping data points in different units of measurement together. Such a basket would however have the currencies' explanatory powers significantly reduced, compared to an ideal scenario where each currency was an independent variable. An additional problem is that Germany and Spain change currencies in the midst of our data period. The currency effect will however materialize in the current market prices, and we believe that Clarksons Research's newbuilding prices indirectly will capture this element.

Government Subsidies

Shipbuilding is a labour intensive, and often export oriented, industry with spill-over effects on the domestic economy as a whole, making it the repeated beneficiary of various forms of government aid in pretty much any nation with shipbuilding output of some size. These subsidies are known to distort pricing mechanisms in the market, as the true production costs might not be covered by the ship owner when ordering new ships (Jon, 2010). The subsidies are however hard to quantify, among other things because not all aid is given in the form of direct monetary support – warship orders from national governments during market busts being one such example. We do nonetheless believe that these effects will be captured by either shipyard fixed effects – for subsidies such as beneficial financing that remain relatively constant over time – or by the current competitive market prices for more short term aid.

5. Data

This chapter will introduce our data, and describe it, as well as the data gathering process. The chapter will also contain a discussion on the representativeness and features of the dataset.

5.1 Data Gathering

Our data sample contains actual newbuilding contracts extracted from Clarksons WFR (2016b), in the period between 1970 and 2014. At the time of gathering, the database contained newbuilding contracts on 91,112 vessels – of which 7,604 observations had a specified and useable contract price. The observations contain information regarding vessel name, contract parties, contract and delivery dates, carrying capacity (DWT and GT), CGT and vessel type. Information specific to the contract parties is also included, such as name, size of shipyard or ship owner and year of first delivery from the shipyard. Said variables enable us to calculate delivery times, yard experience, price in USD per CGT, in addition to create firm size dummies.

Most contracts were compensated in US dollars, while those stated in other currencies were converted to US dollars based on exchange rates at the time of contract signing. We inflated prices to 2014-values by using the US CPI Index. Although the US is pretty much non-existent in both shipping and shipbuilding, its domestic inflation appears to be the most widely used to provide real values in similar studies (Jiang et al., 2013, Akram, 2009, Lizardo and Mollick, 2010). Next, we divided these prices with CGT in order to provide the USD per CGT measure. These steps can to some extent eliminate the role of inflation and currency fluctuations – at least on the revenue side.

Macroeconomic data were collected from a number of sources. Clarksons SIN (2016a) provided newbuilding prices and freight rates for our entire timeframe, indicating current competitive market prices and revenues for a variety of vessel groups. Oil prices were extracted from The International Monetary Fund’s (2016) commodity database, while steel prices were collected through the World Bank Commodity Database (2016a) supplemented with missing data points from Bloomberg (2016). We found currency exchange rates and

GDP per capita in the World Bank WDI database (2016b). All macroeconomic variables were inflated as for previous data, and merged with the existing data set.

The raw data sample contains contracts on several vessel types vastly differing in complexity and size. Table 5-1 presents descriptive statistics of contract prices in USD per CGT for groups of vessels. Bulk carriers, tankers, Fully Cellular Container (FCC) vessels, other dry cargo vessels and Pure Car Carriers (PCC) show similar means, medians and standard deviations - indicating that they are comparable as groups. Other types such as offshore service, cruise, gas carriers and miscellaneous have larger average prices and fluctuations, which might originate from great differences in vessel complexity not captured in CGT – a phenomena that could cause disruptions for overall results. Miscellaneous, PCC, Ro-Ro and reefers are observed few times through the sample period, thus being in risk of measurement errors due to potential outliers and special cases.

In order to minimize the potential errors in our analysis, we disregard all vessel groups except for bulkers, FCCs and tankers. The reasoning behind keeping these particular groups is threefold: Firstly, they all have a great number of observations; secondly they have relatively low standard deviations indicating that USD/CGT values are concentrated around the means, and ultimately these are vessel types that are relatively standardized. By ignoring other vessel groups, we believe that we to a great extent avoid problems related to outliers and special cases. There is reason to believe that other groups, such as e.g. offshore service, have immense variation in equipment level, yielding excessive price fluctuations as CGT does not explicitly account for variations in technical specifications.

Group	Obs	Mean	Std. Dev.	Median	Min	Max
Bulk Carriers	1 354	2 349	580	2 337	1 063	4 475
Cruise/Passenger	471	5 150	6 635	4 969	258	140 136
FCC	1 239	2 600	535	2 658	53	4 758
Gas Carriers	432	3 256	808	3 087	1 693	5 812
Miscellaneous	178	13 336	6 246	14 586	1 407	30 512
Offshore Service	535	6 236	3 224	5 640	962	18 666
Other Dry Cargo	327	2 524	1 139	2 355	825	12 582
PCC	121	2 598	2 209	2 216	759	18 154
Reefer	16	2 818	594	2 888	1 596	3 696
Ro.Ro	117	3 704	1 243	3 375	1 972	8 021
Tanker	1 166	2 387	588	2 274	1 211	5 190
Total	5 956	4 269	2 164	4 217	53	140 136

Table 5-1: USD per CGT for vessel groups

5.2 Data Cleaning

In order to provide a useable data sample, some data cleaning was conducted. Altogether, 1,650 observations were removed due to lack of data for some variables. These are; 896 without specified top speed, 677 without either contract or built date, 15 ships made at unknown shipyard or for an unknown ship owner, 22 without a CGT value, and 40 without specified vessel group. Hence, the final collated data set consists of 5,696 individual vessels constructed at 530 shipyards, spread across 40 countries.

Because bulk carriers, FCCs and tankers are the vessel groups ultimately included in our research, the data set used accumulates to 3,759 observations, in the timeframe between 1990 and 2014. These vessels are manufactured for 835 different ship owners by 77 different shipbuilders, originating from 11 countries.

5.3 Representativeness of Data Sample

At the time of gathering, only 8.5 percent of the vessels included in Clarksons World Fleet Register specified contract price. Such a low sample size could possibly distort the outcome of our analysis, for instance if certain types of contracts are more likely to have their value publicly known. Furthermore, the database only includes vessels in the current fleet, and one could imagine that vessels from certain (poor) yards are more inclined to be scrapped prematurely. Do however note that prices barely were reported at all until the mid-1990s – after which the share of observations with price stabilized at around 15%, as seen in figure 5-1.

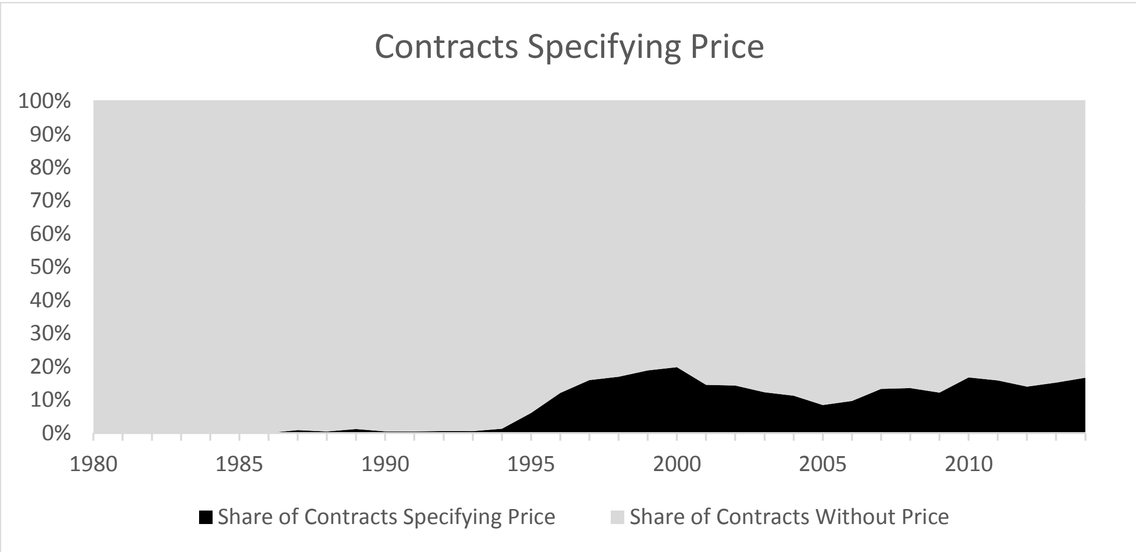

Figure 5-1: Vessels in current fleet with specified contract price. Source: Authors' calculations, data from Clarksons WFR.

There are nevertheless sound indications that our sample is representative. By comparing the USD per CGT values observed in our data set to historical competitive market prices as reported by Clarksons (2016a) in figure 5-2, we find them moving closely in tandem. The larger spread in values found in the data set is expected, simply because there is one observation per vessel – as opposed to one per month for the index. We therefore assume our data sample to provide a satisfactory representation of the shipbuilding market as a whole. Nonetheless, potential influence on our results cannot be ruled out.

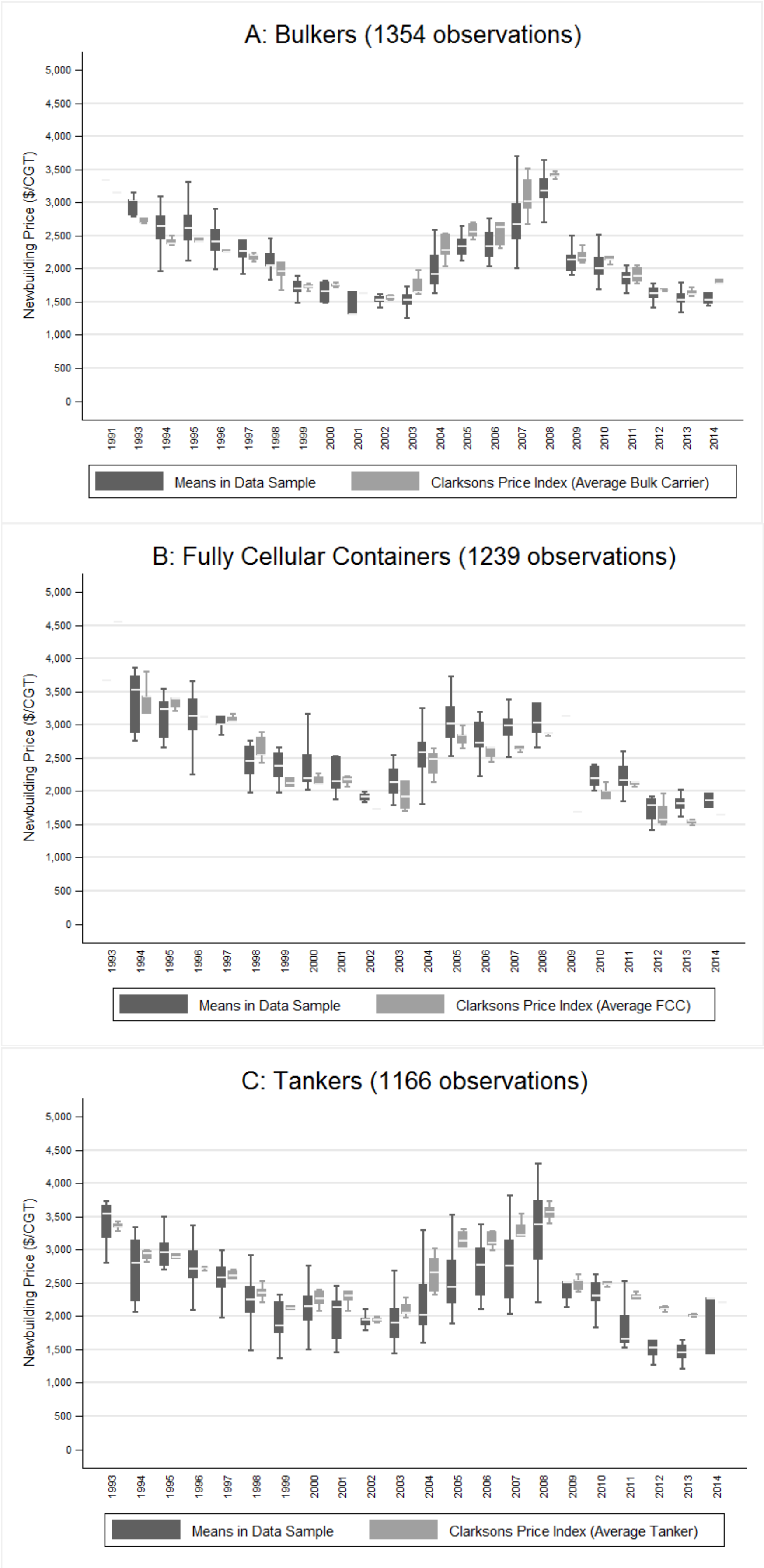

Figure 5-2: Yearly means of contract prices: Bulk, FCC and Tanker markets. Source: Authors' calculations, data from Clarksons WFR.

5.4 Descriptive Statistics

5.4.1 Owner, Yard and Country Specific Descriptive Statistics

Presenting data for each individual ship owner and yard would be chaotic, due to the large number of firms. Therefore, we present variables such as yard experience and delivery times for each country, rather than for each yard. This aggregation seems reasonable, because individuals within the same nation are likely to have emerged in the same time period, and share other common traits (Stopford, 2009).

Yard experience appears affected by established shipyards appearing frequently throughout our sample period, as there is one observation per newbuilding contract. Chinese shipyards exhibit the greatest spread in terms of experience, as expected due to the industry's relatively recent emergence in the country. We observe outliers in delivery times, as a ship rarely arrives as early as 4 months, or as late as 96 months, after contract signing. None of the values are however implausible, and could be caused by for instance the state of the current shipping market, which is affecting delivery time (Adland and Jia, 2015, Adland et al., 2006). Technically inferior/superior vessels, as well as technical or financial problems during the construction phase, could also affect delivery time.

			Yard Experience				Delivery Months			
Country	Obs.	No. Yards	Average	Min	Max	Std. Dev	Average	Min	Max	Std. Dev.
China P.R.	1 319	37	13.2	-5	41	13.3	35.0	5.3	95.9	13.4
Croatia	50	2	43.0	36	49	4.0	35.0	19.2	53.8	7.8
Germany	20	1	34.6	32	38	1.8	17.9	11.5	30.1	4.4
Japan	332	12	29.8	19	45	6.1	25.7	7.9	81.9	9.4
Philippines	30	1	1.8	-2	5	2.4	28.1	15.7	40.0	6.6
Poland	56	3	31.7	28	40	2.9	28.6	8.0	63.3	10.9
Romania	21	1	8.0	6	10	1.3	39.1	24.4	52.0	8.1
South Korea	1 789	16	19.3	-3	43	11.1	29.8	3.7	70.8	10.2
Spain	14	1	29.3	19	33	4.5	26.3	18.3	43.2	6.9
Taiwan	100	2	25.1	17	36	5.8	29.5	15.6	88.7	14.3
Vietnam	28	1	0.3	-2	4	2.2	28.4	13.6	57.8	11.5
Grand Total	3 759	77	18.5	-5	49	12.9	31.2	3.7	95.9	11.9

Table 5-2: Shipyard experience and delivery time (pr. shipyard nation)

Owner and builder frequency is reported for the 10 largest players in table 5-3, while the remainder is grouped as “other”. Market concentration among the top ten shipbuilders varies across segments, from a 42.4 percent market share for bulkers, to 79.8 for tankers and 84.5 for FCCs. Bulk vessels are often less complex than the two other vessel groups, furthermore, tankers and FCCs tend to be larger and hence require greater shipyard facilities - presumably favouring established shipbuilders of some size (Stopford, 2009). The concentration and particular shipyards involved in each segment - for instance the “big three shipbuilders of Korea”[3] building tankers and FCCs – therefore comes as no surprise. In terms of ship owner concentration we find the bulk and tanker market having a concentration of just above 20 percent, while the FCC market displays a concentration of 39.5 percent. COSCO, Maersk and China Shipping are the most frequent owners in the data set as a whole, which seems reasonable as they are among the world’s largest ship operators across segments (Fan et al., 2011).

[3] Hyundai Heavy Industries, Samsung Heavy Industries and Daewoo Shipbuilding & Marine Engineering are commonly referred to as South Korea’s “Big Three”.

Builder yard	Contracts	Percent	Cumul.	Owner (buyer)	Contracts	Percent	Cumul.
A. Bulk market (1354 contracts)							
Jiangnan SY Group	75	5.54	5.54	COSCO Group	56	4.14	4.14
Sinopacific	71	5.24	10.78	China Shpg. (H.K.)	54	3.99	8.12
Hyundai HI	66	4.87	15.66	Pan Ocean	29	2.14	10.27
STX SB	64	4.73	20.38	Eagle Bulk Shipping	27	1.99	12.26
Oshima SB Co	64	4.73	25.11	Genco Shpg & Trading	22	1.62	13.88
Shanghai Waigaoqiao	55	4.06	29.17	Grieg Star	20	1.48	15.36
CSC Jinling Shipyard	48	3.55	32.72	U.Ming Marine Tran.	18	1.33	16.69
Hyundai Mipo	45	3.32	36.04	Sino Shipping Group	18	1.33	18.02
Hudong Zhonghua	43	3.18	39.22	Jinhui Shpg. & Trans	18	1.33	19.35
Sungdong SB	43	3.18	42.39	Dryships	17	1.26	20.61
Other	780	57.61	100.00	Other	1075	79.39	100.00
Total	1354	100,00			1354	100.00	
B. FCC market (1239 contracts)							
Hyundai HI	287	23.16	23.16	Maersk Company	91	7.34	7.34
Samsung HI	189	15.25	38.42	COSCO Group	60	4.84	12.19
Daewoo (DSME)	154	12.43	50.85	CSC Group	58	4.68	16.87
CSBC Group	74	5.97	56.82	MSC	47	3.79	20.66
Hanjin HI (Yeongdo)	70	5.65	62.47	OOCL	45	3.63	24.29
Dalian Shipbuilding	54	4.36	66.83	CMA.CGM	41	3.31	27.60
Jiangsu New YZJ	48	3.87	70.70	APL	41	3.31	30.91
Hyundai Mipo	41	3.31	74.01	Seaspan Corporation	40	3.23	34.14
Shanghai Shipyard	39	3.15	77.16	Rickmers Reederei	33	2.66	36.80
Jiangnan SY Group	33	2.66	79.82	Hapag.Lloyd Cont	33	2.66	39.47
Other	250	20.18	100.00	Other	750	60.53	100.00
Total	1239	100.00			1239	100.00	
C. Tanker market (1166 contracts)							
Hyundai HI	197	16.90	16.90	China Shpg. (H.K.)	49	4.20	4.20
Hyundai Mipo	154	13.21	30.10	Scorpio Group	45	3.86	8.06
Samsung HI	143	12.26	42.37	Teekay Tankers	38	3.26	11.32
Daewoo (DSME)	121	10.38	52.74	Bahri	31	2.66	13.98
Dalian Shipbuilding	108	9.26	62.01	Nat Iranian Tanker	25	2.14	16.12
STX SB	91	7.80	69.81	TORM A/S	24	2.06	18.18
Guangzhou SY Intl	72	6.17	75.99	AET Tanker	23	1.97	20.15
SPP Sacheon SY	38	3.26	79.25	Maersk Company	21	1.80	21.96
Shanghai Waigaoqiao	33	2.83	82.08	BW Maritime	21	1.80	23.76
Brodosplit	28	2.40	84.48	Minerva Ship Mngt	20	1.72	25.47
Other	181	15.52	100.00	Other	869	74.53	100.00
Total	1166	100.00		Total	1166	100.00	

Table 5-3: Top 10 shipyards and owners in the data sample.

Table 5-4 indicates that tanker and FCC owners have a tendency to be larger than those operating bulkers, with more observations in the larger end of the size spectrum. Keep in mind however that each observation is a single ship, and larger operators are expected to contract more frequently in order to maintain the fleet size. The number of observations is generally increasing in yard size for all segments, while we observe no clear pattern for USD/CGT values.

		Price Descriptives (USD/CGT)						Price Descriptives (USD/CGT)			
Owner Size	Obs.	Mean	Std. Dev	Min	Max	Yard size	Obs.	Mean	Std. Dev	Min	Max
A. Bulk Carriers (1354 observations)											
Ex. Large	25	2 546.8	642.2	1 317.7	3 345.2	Large	376	2 299.9	559.8	1 392.5	4 475.3
V. Large	256	2 482.0	571.7	1 411.3	4 020.7	Medium	235	2 342.8	588.4	1 256.6	4 364.0
Large	384	2 331.2	568.7	1 256.6	4 364.0	Mega	484	2 400.7	594.8	1 317.7	4 263.6
Medium	303	2 364.0	548.0	1 336.3	3 955.2	Small	56	2 455.8	469.4	1 747.6	3 345.2
Small	156	2 194.8	489.9	1 317.7	3 351.6	V. Small	15	2 503.1	508.4	1 654.7	3 120.3
V. Small	225	2 402.3	594.7	1 445.9	4 475.3	Unknown	188	2 416.9	494.9	1 378.5	3 330.9
Unknown	5	2 649.7	271.5	2 188.3	2 856.8						
B. Fully Cellular Containers (1239 observations)											
Ex. Large	189	2 711.1	500.3	1 569.9	3 850.9	Large	107	2 558.1	554.5	1 313.4	3 730.9
V. Large	542	2 651.4	507.7	1 313.4	3 850.9	Medium	160	2 590.4	530.5	53.0	3 725.8
Large	259	2 611.8	581.5	53.0	4 758.8	Mega	816	2 659.2	512.2	1 519.2	4 758.8
Medium	129	2 494.7	490.4	1 565.5	3 725.8	Small	67	2 488.1	562.4	1 610.9	3 535.7
Small	67	2 649.8	477.6	1 803.6	4 088.2	V. Small	4	2 374.9	0.0	2 374.9	2 374.9
V. Small	49	2 612.8	567.2	987.9	3 532.5	Unknown	85	2 689.3	537.8	987.9	3 721.1
Unknown	4	2 390.9	433.4	1 831.2	2 889.3						
C. Tankers (1166 observations)											
Ex. Large	38	2 584.3	503.8	1 806.7	3 519.5	Large	50	2 484.2	542.3	1 211.2	4 017.7
V. Large	192	2 329.4	498.0	1 362.4	3 661.3	Medium	127	2 297.8	478.3	1 306.6	3 413.5
Large	432	2 459.5	616.6	1 211.2	5 190.7	Mega	686	2 440.9	576.9	1 359.6	5 190.7
Medium	232	2 318.7	587.6	1 373.5	4 967.8	Small	28	2 194.7	410.3	1 486.4	2 955.6
Small	157	2 321.7	479.8	1 359.6	3 551.7	V. Small	21	2 095.6	471.2	1 784.2	3 025.8
V. Small	106	2 400.5	583.6	1 373.5	4 554.7	Unknown	254	2 321.4	606.0	1 373.5	4 967.8
Unknown	9	2 306.1	520.8	1 882.9	3 404.9						

Table 5-4: Shipyard and owner size descriptive statistics

5.4.2 Macroeconomic Descriptive Statistics

No thorough discussion for the macroeconomic factors will be conducted, because these mainly function as control variables. The main trends will however be presented, and illustrated in table 5-5. Do note that all prices are inflated to 2014-values.

Oil as a commodity is known to be extremely volatile, and exhibits large spreads in monthly averages throughout our timeframe, with a minimum in 1998 at USD 15.12 per barrel and maximum of USD 145.75 per barrel in 2008. The steel price has its 1,099.6 USD per ton peak in the middle of 2008, and lowest value in 2002 at USD 263.2 – a quadrupling of price in six years. Vessel revenues seem most volatile for bulkers, which has a high standard deviation as well as an extreme deviation between minimum and maximum values. A similar pattern is also observed for tankers, while FCCs appear to have more stable rates. Competitive market prices vary from lowest to highest with a factor of between two and three, depending on ship type. FCC is the segment with the greatest market price fluctuations, having its highest value at USD 4,552.0 per CGT in 1993 and lowest at USD 1,482.0 per CGT in 2013. Tanker prices seem to be the most stable, with the lowest spread between the minimum and maximum values, in addition to having the lowest standard deviation.

Macro. Determinants	N	Mean	Std. Dev.	Minimum	Maximum
Oil Price	3 759	62.7	32.3	15.1	145.7
Steel	3 759	620.7	172.6	263.2	1 099.6
Freight Rates ($/day)					
Bulk Carrier	1 354	28 334.9	18 970.7	6 857.2	73 759.4
FCC	1 239	19 445.4	7 719.0	5 097.3	34 710.4
Tanker	1 166	33 605.5	16 009.2	6 909.3	99 832.9
Market Prices ($/CGT)					
Bulk Carrier	1 354	2 452.7	577.3	1 522.4	3 513.3
FCC	1 239	2 472.0	501.7	1 482.0	4 552.2
Tanker	1 166	2 649.1	464.8	1 903.3	3 715.1

Table 5-5: Descriptive statistics of macroeconomic variables

6. Findings and Analysis

6.1 Variable Correlation and Collinearity

A pairwise correlation analysis among our determinants is performed, yielding the correlation matrix in table 6-1. This matrix describes the linear dependence between two random variables bound between -1 and 1, and does not depend on units of measurement (Wooldridge, 2013, p.840). We comment on the nearest correlated variables with significant values, and outline potential reasons and risks.

	USD/ CGT	GT	Speed	Del. Time	F. Rates	Y.Exper.	M. Price	Oil Pr.	Steel Pr.	GDP/Cap.	Y. Size
GT	0.1938*										
Speed	0.2466*	0.2494*									
Del. Time	0.3155*	0.2576*	0.1562*								
F. Rates	0.3238*	0.0274	-0.2960*	0.2780*							
Y. Exper.	0.0400*	0.00630	0.1906*	-0.0898*	-0.2136*						
M. Price	0.6971*	0.0252	-0.0525*	0.3515*	0.6479*	-0.1738*					
Oil Price	0.1367*	0.1882*	0.0385*	0.3396*	0.2192*	-0.1983*	0.1926*				
Steel Price	0.3853*	0.1115*	0.0368*	0.2923*	0.2214*	-0.1684*	0.4484*	0.7449*			
GDP/Cap.	0.1033*	0.1271*	0.1283*	-0.1542*	-0.1739*	0.3597*	-0.0796*	-0.1181*	-0.0610*		
Y. Size	0.0709*	0.2721*	0.2398*	0.1274*	0.0357*	-0.0772*	-0.00770	0.1377*	0.0678*	0.0693*	
O. Size	-0.00520	-0.0836*	0.00180	0.00540	0.000800	-0.0589*	0.0287	0.00920	-0.000100	-0.0422*	-0.0647*

*Statistical significant at a 5 percent level

Table 6-1: Correlation matrix of independent variables

The predicted variable and market price show a close correlation with a coefficient of 0.7, which is expected as the Clarksons market price is supposed to describe the current competitive prices on a USD/CGT basis. Freight rates display positive correlations to our dependent variable and market price of respectively 0.32 and 0.65. An anticipated result, as increased revenue will boost the demand for ships. Steel prices exhibit a correlation of 0.75, 0.39 and 0.45 with oil, contract and market prices respectively, which might be explained by macroeconomic cycles greatly affecting the variables through changes in global demand. Lastly, delivery time displays positive correlations at around 0.3 with freight rates, as well as market, oil, and steel prices - possibly explained by delivery time increasing during boom-periods when shipyards' order books are stacking up. We find remaining correlations unthreatening to our study, but acknowledge that the mentioned correlations could influence our results.

The Variance Inflation Factor (VIF) test is a suited tool to examine whether determinants indicate a risk of multicollinearity or not. A VIF-value of 10 is usually set as a warning level, above which determinants are said to carry risk of multicollinearity in regression estimates. Still, setting a cut-off value for VIF is arbitrary (Wooldridge, 2013, p.94). As expected, we find the interaction variable and freight rates displaying high VIF-values. They appear both in the interaction and separately as control variables, resulting in four values surpassing the threshold value. However, it is generally accepted that high VIF-values for variables constituting an interaction variable safely can be ignored (Allison, 2012). No other values even remotely close to 10 are observed; thus we conclude that the remainder of determinants show no risk of multicollinearity.

Determinants	VIF	1/VIF
GT	1.580	0.634
Speed	1.480	0.674
Delivery Time	3.160	0.316
Low Freight Rate	14.15	0.0707
High Freight Rates	13.63	0.0734
Del. Time * Low Freight Rates	12.62	0.0793
Del. Time * High Freight Rates	15.03	0.0665
Yard Experience	1.280	0.781
Market Price	3.300	0.303
Steel Price	4.510	0.221
Oil Price	2.600	0.384
GDP per Capita	1.230	0.815
Yard Size		
Large	1.120	0.895
Medium	1.190	0.842
Small	1.280	0.784
Very Small	1.140	0.877
Unknown	1.370	0.728
Owner Size		
Extra Large	1.180	0.849
Very Large	1.590	0.628
Large	1.990	0.504
Small	1.520	0.656
Very Small	1.390	0.720
Unknown	1.060	0.946
Mean - VIF	3.890	

Table 6-2: Variance Inflation Factor (VIF) test of multicollinearity

6.2 Microeconomic Regressions

This section outlines estimates of the first regression set, excluding both time-varying effects and macroeconomic variables. Table 6-3 illustrates microeconomic specifications, grouped on bulk carriers, FCCs and tankers to isolate segment specific effects. For firm sizes, we use mega yards and medium owners as base levels to test our hypotheses. Each group contains three specifications, outlined in section 3 (eq. 2 to 4); the first OLS including firm sizes, second introducing shipyard fixed effects, and third adding owner fixed effects. One should keep in mind when assessing results that estimates do not account for time effects or current market conditions.

Reg. #	1	2	3	4	5	6	7	8	9
Group	Bulk	Bulk	Bulk	FCC	FCC	FCC	Tanker	Tanker	Tanker
Dep. Var.	$/CGT	$/CGT	$/CGT	$/CGT	$/CGT	$/CGT	$/CGT	$/CGT	$/CGT
Constant	354.7	1,357***	1,669***	1,296***	1,574***	1,755***	1,545***	877.1***	560.0
	(438.1)	(423.0)	(563.2)	(184.4)	(193.7)	(339.9)	(266.5)	(316.2)	(419.8)
GT	0.000143	0.000120	0.00178*	-0.00364***	-0.00345***	-0.00304***	0.00430***	0.00292***	0.00205***
	(0.000483)	(0.000611)	(0.00102)	(0.000317)	(0.000365)	(0.000429)	(0.000399)	(0.000541)	(0.000681)
Speed	107.4***	35.88	-2.160	40.99***	17.57**	25.64**	7.575	3.916	31.15
	(31.10)	(29.11)	(38.92)	(7.742)	(7.706)	(9.977)	(17.78)	(19.59)	(30.42)
Del. Time	16.29***	14.66***	8.910***	15.16***	19.61***	18.10***	10.67***	16.12***	12.24***
	(1.242)	(1.343)	(2.021)	(1.101)	(1.128)	(1.159)	(1.531)	(1.772)	(2.945)
Experience	-1.076	-13.18***	-7.598*	3.180***	-6.689***	-2.515	5.148***	8.114***	6.725**
	(1.189)	(2.858)	(4.567)	(1.200)	(2.494)	(2.773)	(1.224)	(2.163)	(3.295)
L - Yard	-93.64**			-132.1**			-58.90		
	(37.00)			(61.25)			(65.66)		
M - Yard	-91.69**			-135.7***			-51.20		
	(42.98)			(49.45)			(49.69)		
S - Yard	-82.43			-137.5**			-262.4***		
	(59.56)			(65.42)			(76.53)		
VS - Yard	53.06			-656.3***			-113.9		
	(116.7)			(94.42)			(112.2)		
XL - Owner	80.20	7.060		176.8***	177.8***		150.5*	170.8**	
	(115.9)	(116.4)		(50.13)	(44.65)		(79.50)	(79.26)	
VL - Owner	112.6**	67.41		85.43**	124.7***		-20.29	-26.54	
	(43.67)	(44.22)		(42.37)	(37.06)		(46.84)	(46.98)	
L - Owner	-36.38	-40.52		86.99*	125.3***		77.70	66.53	
	(39.68)	(40.76)		(48.79)	(44.96)		(47.97)	(45.24)	
S - Owner	-130.9***	-140.9***		131.2*	135.8**		103.6**	168.3***	
	(46.26)	(48.12)		(69.60)	(67.81)		(49.22)	(49.44)	
VS - Owner	93.26**	20.25		184.6*	99.81		108.3*	137.9**	
	(46.07)	(47.66)		(94.39)	(76.34)		(61.52)	(61.77)	
Yard FE	NO	YES	YES	NO	YES	YES	NO	YES	YES
Owner FE	NO	NO	YES	NO	NO	YES	NO	NO	YES
Observations	1,354	1,354	1,354	1,239	1,239	1,239	1,166	1,166	1,166
R-squared	0.179	0.339	0.779	0.171	0.418	0.597	0.202	0.407	0.721

(Robust standard errors in parentheses)
* Statistical significant at a 10 percent level
** Statistical significant at a 5 percent level
*** Statistical significant at a 1 percent level

This table illustrates microeconomic standard leverage regressions of 3.759 shipbuilding contracts in the time period 1990-2014. With all values clustered, showing robust standard errors in parentheses. We also induce fixed effects for owners and yards in the specifications.
→XL = Extra Large, VL = Very Large, L = Large, M = Medium, S = Small, VS = Very Small

Table 6-3: Microeconomic regressions

Bulk

Including base determinants (GT, speed, delivery time and yard experience), as well as firm size for the bulk shipbuilding market results in a low explanatory power of 17.9 percent in column 1. As we introduce fixed effects for shipyards and owners in column 2 and 3, explanatory effects increase rapidly with respectively 16 and 44 percentage points. Seeing that coefficients remain rather stable in columns 1 to 3, this indicates that time-invariant unobservable and observable characteristics of both yards and especially owners are important in determining contract prices. Such a result might be explained by superior market insight, enabling certain owners to "time" the market better. In fact, shipping might not per se be the primary business of some ship owners, as Adland (2000) finds that asset play[4] strategies outperform staying long in the freight market.

Speed has positive and significant results in the first column, indicating top speed to increase the shipbuilding price. Its significance does however evaporate as we add fixed effects to the specifications in columns 2 and 3. In contradiction with our expectations, OLS-estimates show a significant positive relationship between delivery time and shipbuilding prices in the bulk market. Escalation of demand might fill up berths and order books at yards, causing market price and delivery time to rise as well. The result is thus possibly explained by the lack of an indicator for macro market cycles, causing delivery time to act as a proxy for such cycles due to its positive correlation with market prices. Yard experience estimates display significant results only in column 2, as shipyard fixed effects are introduced. A negative relationship between contract price and experience is however observed, contradicting our initial predictions.

We find that only L and M yards achieve significant values – both deviating negatively from the prices obtained by mega yards. Bulkers are known to be less complex than the other vessel types, and could thus be contracts mega yards do not normally bid on unless the prices are particularly beneficial, possibly explaining the higher prices these yards obtain. Prices are decreasing in size for the remainder of the yard sizes, in line with the expectations – although no significant values are observed. Estimates for owner sizes show varying significance and large spreads in coefficient values for all owner sizes but S, conflicting with our hypothesis.

[4] Ship owners with asset play as their business strategy will actively buy and sell ships to generate profits.

FCC

The FCC shipbuilding estimates display a low explanatory effect at 17.1 percent in column 4, when adding solely firm sizes to the base of determinants. When yard fixed effects is included in column 5, explanatory power increases with 24.7 percentage points, while owner fixed effects explain less than yards by adding 17.9 percentage points to r-squared in column 6. Estimates indicate that individual yards and owners explain large parts of price movements in the microeconomic specifications. FCCs are considered rather complex, evident by the fact that European yards for a long time maintained some market share in the segment[5]. This might imply that competition is not as fierce among shipyards, possibly explaining some of the fixed effects.

GT exhibits a clear and stable pattern from column 4 to 6, with significant estimates indicating a negative relationship between GT and USD per CGT, contradicting our predictions. The speed determinant appears to have a positive relationship with shipbuilding price, with all specifications displaying significant estimates at a 5 percent level – thus being consistent with our predictions. Delivery time continues to provide positive estimates in the FCC segment. Hence, the effect is still not in line with what we expected, and the result is allocated to delivery time working as a proxy for market cycles - as for the bulker segment. Shipyard experience is positively affecting prices at 1 percent significance in column 4, while changing to a negative relationship at the same level of significance in column 5 as shipyard fixed effects are introduced.

Significant estimates at minimum the 5 percent level occur for all deviations from mega yards in column 4. Results indicate that prices generally are increasing in yard size, which is quite the opposite of the relationship we proposed. The major deviation observed for VS yards could be explained by the characteristics of the FCC segment. These vessels are typically large, and an order book of merely a single FCC vessel could make the shipyard fall into a category larger than VS – as size is categorized based on order book. Thus it seems reasonable that the FCC observations for VS yards must be some form of outliers. When assessing owner size estimates, we find at minimum 5 percent significance that both larger (XL, VL and L) and smaller (S) owners tend to pay more for their ships than medium

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[5] One notable example being Odense Staalskibsværft in Denmark, which until its recent closure primarily built ships for its owner AP Møller-Mærsk – the largest player in the container segment.

owners do. Prices do also appear to be more or less increasing in owner size, except for M – contrary to initial expectations. As touched upon earlier, the largest player did for some time own their own shipyard, which could influence prices. Furthermore, the top 10 ship owners account for almost 40 percent of our FCC observations; an indication that smaller owners are more susceptible to outliers.

Tanker

Column 7 displays the first tanker estimates, with determinants explaining 20.2 percent of price movements. When introducing fixed effects in columns 8 and 9, yard fixed effects add 20.5 percent, while owner fixed effects add 31.4 percentage points to explanatory power - resulting in a total of 72.1 percent. Both owner and shipyard heterogeneity seem important in determining price movements, and the large explanatory power added from introducing owner fixed effects is similar to the bulk market - a result we once again allocate to market timing or asset play strategies. Yard heterogeneity, on the other hand, might be explained by e.g. specialization premiums, bargaining power or superior ship designs.

GT has a positive relationship with USD per CGT for the tanker market with positive and significant coefficients values appearing stable throughout all three specifications - in line with our predictions. The positive impact on contract prices caused by delivery time continues for the tanker segment, as seen in columns 7 to 9. Hence, significant results contradict our predictions. As for the bulk and FCC market, we allocate this positive relationship to delivery time working as proxy for market cycles. The yard experience determinant in columns 7 to 9 has significant positive coefficient values, which makes this segment differ from the other two by displaying a positive relationship - supporting our predictions. Seeing that significance levels and coefficients stay stable as determinants change, we find the maturity of a yard positively affecting contract prices.

Only S yards display significant estimates, indicating that these charge less than mega yards. As only one significant estimate occurs, however, no clear conclusion on the effects of yard size can be made. In terms of owner size, we observe varying coefficients and weak significance. Worth noticing is the significant and positive deviations for both S and VS owners. XL owners also has positive significant coefficients, and parts of the findings are thus in line with our predictions, but the lack of a distinct significant pattern rejects our hypothesis.

6.3 Macroeconomic Regressions

Our second set of specifications adds macroeconomic variables, including time-varying effects to the estimates. Table 6-4 illustrates estimates of the macroeconomic regressions. We introduce an interaction determinant between freight rates and delivery time, assessing high/low rate deviations from medium rate interactions. Discussions of the two variables separately are irrelevant, as they appear merely to avoid specification errors when we introduce the interaction variable. The separation of vessel groups and specifications persists to isolate the effects of determinants. We outline and briefly comment on findings from these specifications for each vessel group.

Reg. #	1	2	3	4	5	6	7	8	9
Group	Bulk	Bulk	Bulk	FCC	FCC	FCC	Tanker	Tanker	Tanker
Dep. Var.	$/CGT	$/CGT	$/CGT	$/CGT	$/CGT	$/CGT	$/CGT	$/CGT	$/CGT
Constant	-1,671***	-921.2***	152.0	-13.09	-361.3**	-365.9	-412.9*	-11.86	-170.5
	(325.5)	(335.9)	(328.5)	(153.8)	(163.9)	(249.2)	(228.6)	(242.8)	(325.8)
GT	-0.000275	-0.000653*	-0.000249	-0.000616***	-0.00104***	-0.000995***	0.00347***	0.00177***	0.00144***
	(0.000290)	(0.000365)	(0.000477)	(0.000227)	(0.000263)	(0.000296)	(0.000271)	(0.000314)	(0.000431)
Speed	97.61***	52.07**	-5.723	22.81***	20.01***	29.34***	33.51**	9.051	9.820
	(23.09)	(23.09)	(20.21)	(4.892)	(6.175)	(8.218)	(13.63)	(13.85)	(22.19)
Del. Time	-0.452	1.043	-0.404	3.771***	4.922***	4.940***	-4.639**	-3.058*	-5.973***
	(1.233)	(1.352)	(2.144)	(0.990)	(1.043)	(1.146)	(2.167)	(1.814)	(2.187)
L - Rates	-84.42	-56.51	52.43	-166.0**	-217.2***	-309.1***	-154.7*	-157.2*	-262.8***
	(86.94)	(82.26)	(103.7)	(73.92)	(80.42)	(90.55)	(92.01)	(86.77)	(100.4)
H - Rates	-32.59	16.96	-25.92	-107.5	-123.6	-73.43	-486.3***	-396.3***	-402.9***
	(70.72)	(73.50)	(92.87)	(83.32)	(83.02)	(86.53)	(86.08)	(81.44)	(112.3)
L - Rates*Del. T.	7.781**	4.863*	0.461	0.628	3.326	7.804**	3.118	2.434	9.307***
	(3.254)	(2.931)	(3.254)	(2.391)	(2.650)	(3.171)	(3.029)	(3.101)	(3.535)
H - Rates*Del.T.	-3.061*	-4.396**	-3.195	3.658*	3.776*	3.065	10.66***	8.085***	10.39***
	(1.680)	(1.739)	(2.460)	(1.944)	(2.002)	(2.073)	(2.609)	(2.442)	(3.553)
Experience	4.246***	-0.110	-1.365	1.069	3.376**	0.965	9.016***	1.598	2.403
	(0.672)	(1.456)	(1.751)	(0.824)	(1.583)	(1.689)	(0.986)	(1.290)	(1.931)
Index	0.969***	0.930***	0.971***	0.668***	0.668***	0.662***	0.805***	0.735***	0.825***
	(0.0336)	(0.0341)	(0.0511)	(0.0419)	(0.0402)	(0.0460)	(0.0450)	(0.0458)	(0.0657)
Steel Price	0.390***	0.264**	-0.0786	0.392**	0.220	0.263	0.357**	0.0182	-0.00750
	(0.101)	(0.106)	(0.187)	(0.155)	(0.164)	(0.193)	(0.149)	(0.135)	(0.202)
Oil Price	-1.097**	-0.799	0.678	-0.403	-0.743	-0.230	-4.719***	-1.422*	-0.943
	(0.476)	(0.582)	(0.968)	(0.845)	(0.915)	(1.056)	(0.812)	(0.787)	(1.228)
GDP/Capita	0.00305***	0.00839***	0.0106***	0.00760***	0.0176***	0.0159***	0.00231**	0.0290***	0.0203***
	(0.000573)	(0.00176)	(0.00250)	(0.000929)	(0.00285)	(0.00354)	(0.000959)	(0.00398)	(0.00614)
L - Yard	-38.24*			-89.89***			11.87		
	(20.06)			(31.63)			(45.59)		
M - Yard	-6.475			-52.42*			-44.02		
	(26.61)			(31.56)			(36.68)		
S - Yard	12.75			-71.32*			-193.2***		
	(36.70)			(41.25)			(72.62)		
VS - Yard	-90.80**			-303.6***			46.02		
	(38.13)			(68.63)			(69.27)		
XL - Owner	-30.64	-8.469		82.11***	113.4***		79.86	27.53	
	(62.55)	(62.83)		(26.84)	(26.79)		(53.23)	(54.15)	
VL - Owner	29.70	34.38		56.12**	61.34**		-51.71	-53.59	
	(22.53)	(21.76)		(24.32)	(23.98)		(34.85)	(34.53)	
L - Owner	25.93	34.85*		55.96*	100.3***		64.42*	52.01	
	(21.88)	(20.39)		(30.34)	(32.25)		(36.77)	(32.90)	
S - Owner	-7.228	8.805		64.84*	111.4***		-25.75	12.40	
	(23.47)	(24.27)		(33.61)	(33.21)		(38.44)	(36.95)	
VS - Owner	53.01**	39.48		-35.30	-56.77		-42.83	-41.80	
	(26.52)	(28.60)		(69.39)	(60.78)		(50.85)	(45.50)	
Yard FE	NO	YES	YES	NO	YES	YES	NO	YES	YES
Owner FE	NO	NO	YES	NO	NO	YES	NO	NO	YES
Observations	1,354	1,354	1,354	1,239	1,239	1,239	1,166	1,166	1,166
R-squared	0.739	0.795	0.946	0.715	0.754	0.825	0.554	0.703	0.876

(Robust standard errors in parentheses)
* Statistical significant at a 10 percent level
** Statistical significant at a 5 percent level
*** Statistical significant at a 1 percent level

This table illustrates macroeconomic standard leverage regressions of 3.759 shipbuilding contracts in the time period 1990-2014.
With all values clustered, showing robust standard errors in parentheses. We also induce fixed effects for owners and yards in the specifications.
→ XL = Extra Large, VL = Very Large, L = Large, M = Medium, S = Small, VS = Very Small

Table 6-4: Macroeconomic regressions

Bulk Carriers

Macroeconomic determinants affect r-squared positively, with column 1 explaining 56 percentage points more than the first microeconomic specification for the bulk market. In column 3, determinants explain 94.6 percent of contract price movements as we introduce yard and owner fixed effects. Separately, yard and owner unobservable and observable characteristics account for respectively 5.6 and 15.1 percent of the total explanatory power. Owner characteristics account for more of the variation than shipyards, which could be explained by the same firm characteristics as in the microeconomic specifications. As expected, both competitive market prices and GDP/capita exhibit positive relationships with the predicted variable throughout all specifications for the bulk market.

GT has a negative impact on contract price throughout the specifications, but fails to reach acceptable significance. Effects from the top speed of a vessel are positive and significant in column 1 and 2, coefficient significance is however eradicated in the last specification – an indication of weak influence. The interaction determinant supports our hypothesis of a negative relationship between delivery time and contract prices when freight rates are high. The support of our hypothesis is however weak, as coefficient significance evaporates when explanatory power peaks in column 3. When assessing yard experience estimates, we find column 1 supporting our predictions of a positive relationship between yard experience and price. Fixed effects nullify both the positive relationship and the significant values however, forcing us to reject the hypothesis. Size determinants for shipyards appear significant at the 5 percent level or better only for VS yards. In terms of owner size, column 1 and 2 show weak significance, with VS as the only owner size reaching a significance of 5 percent in column 1. Weak significance forces us to reject the hypothesis of owner or yard size affecting prices in this market.

FCC

In column 4, the explanatory power increases with 54.4 percentage points compared to the first microeconomic specification for the FCC market. Fixed effects for shipyards and ship owners introduced in columns 5 and 6 account for 3.9 and 7.1 percent of the price movements, increasing explanatory power to 82.5 percent. Owner and yard characteristics display weaker effects in this segment, compared to the bulk market. However, buyer heterogeneity is still more important than that of shipyards in explaining price variability. As for the bulk market, we expect this to originate from market timing.

The market price index continues to affect shipbuilding prices positively, and it is together with GDP/capita the only macroeconomic variable significantly affecting price movements. GT keeps its significant and stable negative relationship with contract prices from the microeconomic specifications, contrary to initial expectations. This effect is possibly explained by economies of scale at shipyards; although total price might be increasing in GT, the price per CGT could very well be decreasing in GT as each additional GT adds less and less to the shipbuilders' total costs. We find vessel top speed keeping its positive relationship with contract prices, supporting our hypothesis. The interaction between delivery time and freight rates displays a single significant value in the FCC market, as delivery time has a positive impact on prices when rates are low. Shipyard experience has only one significant coefficient, which indicates the variable to have a positive effect on the dependent variable.

All yard sizes display negative price deviations when compared to mega yards, while VS and L are the only two achieving significant coefficients. Prices appear to be increasing in shipyard size, hence contradicting with our hypothesis and the argument of economies of scale. We find all but VS owners tending to pay significantly more for their vessels than medium owners do. The deviations do also lack a distinct direction, which makes us reject the hypothesis of owner size positively affecting contract prices.

Tanker

Macroeconomic determinants increase the tanker segment explanatory power with 35.2 percent compared to the corresponding microeconomic specification. As yard and owner fixed effects are added in columns 8 and 9, explanatory power increases with 14.9 and 17.3 percent, respectively. Thus, tanker market owner and yard firm characteristics account for larger parts of price movements than in the bulk and FCC segments – without any clear indications as to why this is the case. The fixed effects could be explained by similar arguments as for the bulker and FCC markets. As seen in column 9, tanker market determinants overall explain 87.6 percent of the variability in contract price.

We find the competitive market price determinant for tankers affecting contract prices positively, which is a result it shares with GDP/capita. All other macro-determinants fail to achieve significant coefficients as explanatory power peaks, thus proving a weak effect on the contract price. GT keeps its positive and significant relationship with contract prices from the microeconomic specifications. Speed, on the other hand, fails to deliver significant values for its positive coefficients as explanatory power increases. The interaction determinant of delivery time and freight rates exhibits an unclear pattern for this market. In column 9, results indicate one month added in lead-time to cause a positive price deviation, at rates both higher and lower than medium. Yard experience fails to reach significant values despite having estimates in line with expectations. The effect of yard sizes on the tanker price movements appears inconsistent, with no clear trend. Nonetheless, S yards continue to achieve significant coefficients at the 1 percent level. Thus, some effect is caused by shipyard size, but the evidence needed to support our hypothesis is not present.

7. Conclusion and Further Research

The purpose of this thesis was to investigate which factors that are determining prices in the shipbuilding market. Data on individual shipbuilding contracts for bulker, tanker and container vessels during the 1990-2014 period formed the basis for the investigation of covariates' effect in the separate segments. Determinants derived from above mentioned contract observations, as well as market conditions, make up the covariates for this study.

Regression results prove there to be differences between the three segments. We find macroeconomic determinants as competitive market prices and GDP/capita being the most influential covariates. Nonetheless, results indicate that GT, top speed, delivery time - as well as shipyard and ship owner observable and unobservable firm characteristics - play important roles in explaining USD per CGT movements. Firm size and yard experience, on the other hand, fails to affect price movements. GT provides negative significant effects on FCC contracts, while having a positive relationship with USD per CGT in the tanker segment. We allocate this to economies of scale, as each additional GT costs the shipyards less and less for a container vessel, while the opposite seems to be the case for tankers. Vessel top speed significantly influences contract prices in a positive manner in the FCC segment. For the tanker and FCC markets, the interaction of delivery time and low freight rates proves a positive deviation from the medium rate interaction, suggesting that increased lead times will increase the contract price. Fixed effects estimations indicate individual shipyards and ship owners to be large contributors to price formations in all segments, with the largest effects appearing for tankers. Similar for all vessel groups is that owners play a larger role than shipyards in explaining price movements.

We acknowledge that a small sample size might affect the results of our study. Shipbuilding contracts specifying price is unfortunately only the case in 8.5 percent of the contracts published by Clarksons World Fleet Register. Through removing several observations due to lack of information (speed, built date, contract date, name of yard/owner, CGT and vessel group), the initial sample size is considerably reduced. We do not include scrapped vessels either, further reducing sample size. This filtering of observations might result in under/over estimation of the influence from covariates or shipyard and owner fixed effects. Furthermore, the study is to a large extent based on the assumption that CGT is a perfect measure of shipyard output – a condition we acknowledge is extremely unlikely to hold.

We assume in our econometric approach that time-invariant observable and unobservable characteristics of shipyards and owners exist, affecting the formation of individual contract prices. The firm characteristics affecting prices are hard to observe, which is why we merely focus on proving its existence rather than pinpointing the exact cause.

Further research in this area should try to obtain larger initial data samples, and include shipbuilding prices on scrapped vessels. It should also consider the possibility of deriving alternative proxies for complexity, and make a continuous variable for the size of owners and yards in order to better measure the real effects of firm size on contract prices. Lastly, the delivery time variable could be interacted with continuous freight rates, in order to measure its direct impact.

8. References

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