Maritime Transportation and Harvesting of Sea Resources – Guedes Soares & Teixeira (Eds)
 ISBN 978-0-8153-7993-5

Shipbuilder country and second hand price: Some empirical evidences

R.B. Fiasca, L.F. Assis & F.C.M. Pires Jr.
Federal University of Rio de Janeiro, Rio de Janeiro, Brazil

ABSTRACT: The article presents an econometric analysis to test the hypothesis that the builder's country influences the second hand ship value. The analysis is based on econometric modelling of second hand ship prices, having, as regressors, deadweight, age, indexes of earnings and newbuilding prices, LIBOR, and dummy variables representing the building country or region. Models specific for tankers, bulk carriers and containerships were estimated. The analysis has evidenced that, in general, the effect of the origin of the ship on the second hand price may be statistically significant.

1 INTRODUCTION

The literature on second hand ship pricing can be divided in two strands: the first focusing on time series models, and the second, on structural models (Adland & Koekebakker 2007, Pruyn et al. 2011).

A seminal work in second hand ship pricing was Beenstock (1985) that, based on econometric structural modelling, has established that the ship prices vary directly with the expected return on investment in ships, and inversely with the return on alternative investment. The return on ship investment depends on the net income and capital gain. The work confirms the Efficient Market Hypothesis (EMH) that states that an asset's price fully reflect all available information.

Beenstock & Vergottis (1993), in the same strand, developed a general model for world shipping markets forecasting, including the second hand market, assuming that the second hand markets are efficient. Hale & Vanags (1992) and Glen (1997) developed time series analysis on second hand value of ships, focusing on testing the EMH.

Some other works based on autoregressive time series models were developed aiming at analysing several issues, like: price volatility for different kinds of ships (Kavussanos 1997); ship price and market size (Alizadeh & Nomikos 2003); ship investment decision making combining technical trading rules and fundamental analysis (Alizadeh & Nomikos 2007); and the existence of lead-lag effect between newbuilding and second hand prices (Kou et al. 2014).

The main concern of the present paper is to identify the critical variables to consider in simple econometric models oriented to assessing the relevance of the shipyard or builder's country or region for price formation in second hand ships market. Several previous articles contributed to this purpose.

Tsolakis et al. (2003) developed partial equilibrium models, for bulkers and tankers, in which the ship demand depends on time-charter rates, second hand ship prices, newbuilding prices, and capital cost (LIBOR). On the other hand, the supply depends on the orderbook to current fleet ratio and the second hand ship prices.

Most econometric models adopt time charter rates as explanatory variables. However, some authors consider using spot rates, as, for example, Strandenes (2002).

Adland & Koekebakker (2007) developed a second hand price model based on bulkcarriers sale and purchase cross-sectional data, taking ships' size and age and charter rates as explanatory variables. The authors point out that this kind of model would be improved by considering other influencers, like cargo handling equipment, speed, fuel consumption as well as the shipyard and building country.

Merikas et al. (2008) analysed the newbuilding versus second hand investment option for tankers. The authors point that the second hand to newbuilding prices ratio may be explained by time charter rates, cost of capital (LIBOR), petroleum price, shipbuilding cost and freight rate volatility (estimated through a second order autoregressive time series model).

Köhn (2008) analysed the second hand value of chemical tankers taking the building country as an explanatory variable. The analysis found significant differences between the prices of ships built in Japan and 11 countries, out of 17 existing in the sample.

Pruyn et al. (2011) developed a broad review on second hand ship value literature from 1991 to 2011. That paper states namely that in the first 10 years the main trend was to focus on testing the Efficient Market Hypothesis, but the current ideas focus on a micro-economic valuation of the vessel, incorporating particulars such as DWT, age, speed, horsepower, hull type and many others. The authors suggest that the following variables should be considered: newbuilding price level, orderbook size (relative to the fleet), earnings, time charter rate, bunker costs, age and cargo capacity. They observe that speed and horsepower can also be relevant, albeit difficult to obtain, but do not include the building country.

Pruyn et al. (2011) pointed that Adland & Koekebakker (2007) and Köhn (2008) had evidenced significant influence of building country on second hand value. However the findings of Pruyn et al. (2011) show that the classification society and building country are not significant influencers.

Pires et al. (2011) developed an econometric model that produced robust evidences of influence of building country in second hand value. However, that work used only data from three years (2003 to 2005) and had some other limitations. Individual models were estimated for each year (2003, 2004 and 2005), and for three classes of ships: bulkcarriers, tankers and containerships. The dependent variable in the basic model is the price (US$/dwt), and the explanatory variables are size, age and dummy variables related to building country. In order to take in account the market time variation, the price indexes were deflated by global second hand price indexes published by Clarksons Research.

The main limitation was the presence of critical bias in some samples that made the estimation unfeasible. For instance, in the case of tankers, the biggest ships (VLCC and ULCC) were mostly Koreans, while the smallest and oldest were mostly Japanese, and there were very few ships from other countries. In the case of containerships, there was a concentration of European-built ships in the oldest group and Korea-built in the newest. At same time, there was a concentration of European-built in the biggest ships range in the sample and Japanese-built among the smallest. There was also very few containerships built in other countries in the sample. Only the bulkcarriers sample was well conditioned, when split in ships built in Japan and elsewhere.

The present work considers data from 2003 to 2014, and the sample will not be segregated by year. Different models will be estimated for the same three types of ships. The expanded samples permit the critical bias to be eliminated or reduced, strongly improving the analysis robustness.

2 MODEL SPECIFICATION

The proposed model is indicated in Equation (1).

$$P = DWT^{\alpha} \cdot age^{\beta} \cdot earnings^{\gamma} \cdot NB^{\delta} \cdot LIBOR^{\tau} \cdot e^{a \cdot A} \cdot e^{b \cdot B} \cdot e^{c \cdot C} \quad (1)$$

where P (US$/DWT) = ship price per dwt; earnings (US$/day) = index to capture the time variation of ship's earning capability; NB (US$/DWT) = index to capture the time variation of newbuilding market price for each ship type; LIBOR = representing the cost of investment capital; A, B, C = dummy variables representing the building countries or regions.

The data were obtained from Clarksons (2016). Only ships classified as bulkcarriers, full-containerships and tankers were included in the sample. Ships sold before completing one year from delivery were not considered.

In order to identify and eliminate outliers, the prices (US$/dwt or US$/TEU) were deflated by the monthly *Clarkson Second Hand Price Indexes* (Clarksons 2016) corresponding to the respective ship type:

- Bulk Carrier Secondhand Prices Index Average (US$/dwt).
- Tanker Secondhand Prices Index Average (US$/dwt).
- Containership 10 year old Secondhand Prices Index Average (US$/TEU).

The data out of the following limits were considered as outliers:

$$Inf = Q_1 - 1.5 \times (Q_3 - Q_1)$$

and

$$Sup = Q_3 + 1.5 \times (Q_3 - Q_1)$$

In the above expressions, Q1 and Q3 are the upper limits of the first and the third quartiles.

There were, before eliminating outliers, 4,220 bulkcarriers, 1,312 tankers and 992 containerships in the sample. The number of outliers was 31 (0.73%), 50 (3.81%) and 9 (0.91%), respectively.

The variables *earnings* and NB in Equation (1) are described in Table 1.

The building regions were defined taking in account the number of sold ships and the homogeneity of shipbuilding patterns. Normally, each region or country has shipyards with very different production patterns. Nevertheless, this grouping aims at identifying possible valuation bias by the market players, related with the general quality perception on the national or regional products.

Table 1. Earnings and newbuilding prices indexes.

	Earnings	Newbuilding price
Bulkcarriers	Baltic Exchange Dry Index	Bulkcarrier Average Newbuilding Prices (US$/dwt)
Tankers	Average Weighted Earnings All Tankers (US$/day)	Oil Tanker Average Newbuilding Prices (US$/dwt)
Container-ships	Clarksons Containership Earnings Index (US$/day)	Containership Contracting (US$)/ Containership Contracting (dwt)

Source: Clarksons (2016).

Some groups result excessively small and were discarded. For example, in the case of containerships, the group contained only three ships built in the American Continent (two in the USA and one in Argentina). The whole set of groups to be considered is: America (South, Central and North America), Asia (except China, South Korea and Japan), China, Europe, Japan and South Korea.

3 MODEL VALIDATION

Before testing hypothesis of influence of building country, the model must be analysed for the presence of multicollinearity and heteroscedasticity.

Multicollinearity occurs when there is a high correlation between linear combinations of different sets of explanatory variables. Perfect multicollinearity prevents the model estimation. In the case of less than perfect multicollinearity, the variance of the model parameters can be very high, affecting the efficiency of the model. However, even in the presence of quasi-multicollinearity, the estimators from Ordinary Least Squares (OLS) still are the BLUE (Best Linear Unbiased Estimator) estimators.

For an initial multicollinearity test, OLS estimators were obtained for the three classes of ships, from the model of Equation (2).

$$\begin{aligned}\ln(P) = K + \alpha\cdot\ln(DWT) + \beta\cdot\ln(age) \\ + \gamma\cdot\ln(earnings) + \delta\cdot\ln(NB) \\ + \tau\cdot\ln(LIBOR)\end{aligned} \tag{2}$$

A typical indication of this problem is a high Coefficient of Determination (R^2) and, at same time, non-significant parameters estimators. This is not the case in the present analysis. All the Coefficients of Determination are higher than 0,7, and all estimators are significant (the p-value is lower than 0.3% for the variable τ, for tankers, and lower than 0.001% for all the other variables).

The second evidence could be high coefficients of correlation between linear combinations of explanatory variables. In the present analysis, only pairwise correlations were analysed. Considering the kind of variables in the model, the risk of presence of relevant correlations between more complex combinations does not seem significant.

The following coefficients of correlation (higher than 0.5) were considered critical:

- ln(LIBOR) and ln(earnings) = 0,7140, for tankers
- ln(LIBOR) and ln(earnings) = 0,7436, for a containerships
- ln(LIBOR) and ln(NB) = 0,6465, for tankers

Since the shipping markets are integrated with the global economic system, some correlation between ln(LIBOR) and ln(earnings) was expected. The issue to consider is at what extent this correlation affect the efficiency of the models, and whether or not any variables should be discarded. Hence, successive regressions were performed, omitting the variables one at a time. Models with and without each variable were compared through the *adjusted-*R^2 and by the likelihood ratio test.

The likelihood ratio tests indicated that the variables ln(earnings) and ln(LIBOR) should be maintained in all the cases. The direct comparison of *adjusted-*R^2 leads to the same conclusion. The same occurs in the case of ln(NB) for tankers.

The conclusion is that, even in the presence of moderate multicollinearity, the recommendation is to keep all the explanatory variables.

Next, the models were tested for multicollinearity. Multicollinearity does not imply violation of the OLS assumptions. The estimators are still unbiased and consistent. The larger standard errors of estimators did not harm the relevance of the analysis.

Next, the model was tested for heteroscedasticity applying the White test (White 1980)). The test indicated that the homoscedasticity hypothesis can be rejected, for the three ship types.

A graphical analysis of the residuals clearly indicated that the heteroscedasticity is partially introduced by the higher variability of prices of ships with age higher than 20 years. This effect should be expected due to the higher variability of the condition of older ships. Also, the life extension of ships normally requires large amounts of investment.

Therefore, the next step was to eliminate from the sample the ships older than 20 years. The sample sizes significantly decreased: 4,189 to 2,765 bulkcarriers, 1,262 to 1,020 tankers and 983 to 877 containerships. All the *adjusted-*R^2 increased, indicating an improvement in the explanation capability of the models. However, the White test indicated that the models remained heteroscedastic.

Some alternative Weighted Least Squares models were estimated, but it was not possible to get a homoscedastic model.

The alternative approach was to apply method proposed by White (1980) to correct the standard errors of the coefficients in regression models, to produce consistent standard errors, for OLS estimators under heteroscedasticity. Theory states that a regression model suffering from heteroscedasticity may produce incorrect significance level for the different variables, through a misleading estimate of the included variables' standard errors. These standard errors have a tendency to be under-predicted, resulting in increased chance of getting significant values, when this is not the case. Thus, the White correction produces robust standard errors, enabling hypothesis testing (Wooldridge 2012). The models were estimated and tested again, accordingly White (1980) method. The whole set of estimators resulted significant, enabling the full acceptation of the basic model.

4 EFFECT OF BUILDING COUNTRY

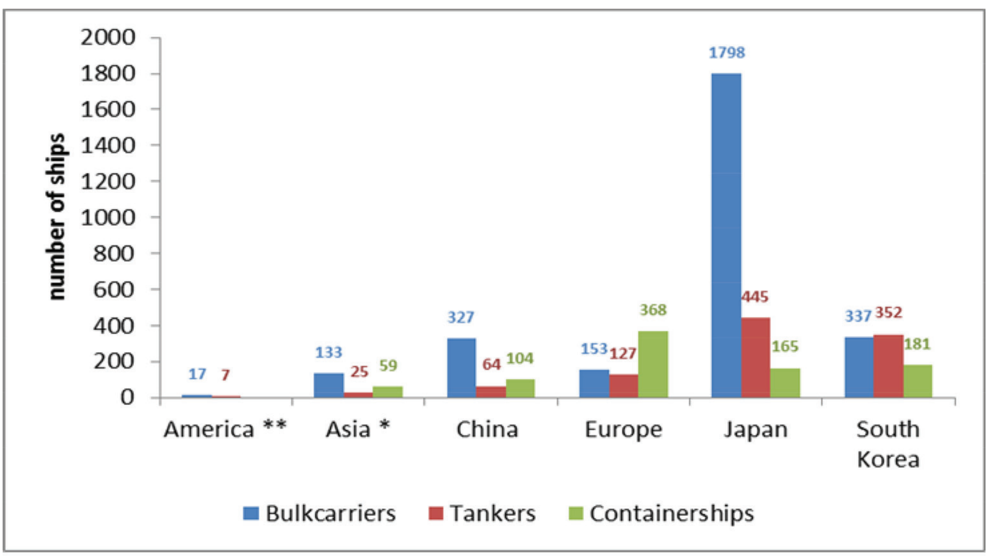
After the elimination of outliers and ships older than 20 years, the sample distribution by building region became as indicated in Figure 1.

The estimators for the model in equation (1) are indicated in Table 2.

The model for bulkcarriers in Table 2 did not included ships built in America. However, an alternative model including those ships (increasing the total sample size to 2,765 ships) was estimated, but the results did not change significantly. The results point out that second hand prices of ships built in Japan and South Korea tend to be significantly higher, ceteris paribus. Moreover, there are no significant differences between these countries.

The model also indicates that prices of ships from groups China and Asia are significantly lower than prices of similar ships from Europe group. However, the latter includes older ships and countries with quite heterogeneous characteristics. Thus, a more specific analysis would be required in order to get a meaningful conclusion on this point. The group Europe for bulkcarriers includes Bulgaria, Croatia, Denmark, Germany, Italy, Poland, Romania, Russia, Spain, Ukraine and the United Kingdom. The Asia group is India, Indonesia, Philippines, Singapore, Taiwan and Vietnam.

In the case of tankers, the model did not evidenced differences between the groups China, Asia, Japan and Europe. On the other hand, differences were detected between America and Europe, as well as between Korea and Europe, although with limited statistical significance (respectively 7.8% and 6.9% p-value). The sample contains 352



*Except China, Japan and South Korea
**South, Central and North America

Figure 1. Ships grouped by building region—Final sample.

Table 2. Econometric model for analysis of the effect of building country[1].

	Bulkcarriers[2]		Tankers		Containerships	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Constant	1,76532	0,201336	1,83851	0,00014	–1,25539	0,01528
ln(DWT)	–0,488612	0,0116475	–0,40852	0,00001	–0,184654	<0,00001
ln(age)	–0,375408	0,00983599	–0,530695	0,00001	–0,457338	<0,00001
ln(earnings)	0,371349	0,0118454	0,111915	0,00006	0,569318	<0,00001
ln(NB)	0,975878	0,024777	1,12337	0,00001	0,560537	<0,00001
ln(LIBOR)	0,144508	0,006685	0,143016	0,00001	0,149054	<0,00001
America			0,232935	0,07843		
China	–0,112298	0,0202329	0,0660184	0,27563	–0,033989	0,54611
Korea	0,00566307	0,0168905	0,0753987	0,06941		
Europe	–0,197609	0,025918			–0,19314	<0,00001
Asia	–0,0694265	0,0299168	0,0510543	0,52092	–0,150505	0,01289
Japan			0,0400695	0,31690	–0,139291	0,00069
Residual Sum of Sq	207,3939		126,2763		121,1742	
p-value (F)	0,000000		1,3e-279		2,8e-261	
R^2	0,829127		0,751562		0,759367	
Adjusted R^2	0,828566		0,749100		0,756870	
Log-likelihood	–348,8149		–381,8837		–376,4957	
Sample size (ships)	2748		1020		877	
Base	Japan		Europe		South Korea	

1 – heteroscedasticity-consistent standard errors; 2 – sample without America.

ships from Korea, 127 from Europe, and only 7 from America. Thus, the only relevant evidence is that Korean tankers tends to be more valuable than European similar vessels. The group Europe for bulkcarriers includes Bulgaria, Croatia, Denmark, Finland, France, Italy, Poland, Portugal, Romania, Russia, Spain, Ukraine and the United Kingdom. The Asia group is Malaysia, Singapore and Taiwan.

Finally, in the case of containerships, the model points to significant evidence that ships from Europe, Asia and Japan are less valuable than Korean similar vessels. Difference between China and Korea was not detected. However, the sample is somewhat biased, with Chinese vessel sizes concentrated in the lower ranges. This bias possibly hinders the comparison between China and Korea. The group Europe for bulkcarriers includes Belgium, Croatia, Denmark, Germany, Italy, Netherlands, Norway, Poland, Romania, Spain and the United Kingdom. The Asia group is Indonesia, Singapore, Taiwan and Turkey.

5 CONCLUSIONS

The hypothesis that the builder's country influences the second hand price of ships is tacitly accepted at the international market. Countries whose products are perceived as high quality are, for example, Japan and most West European. On the other hand, the market tends to consider as lower quality ships those built in China, Brazil and most East Europeans countries.

The article presents an econometric analysis to test the hypothesis that the builder country influences the second hand ship value, as well as identifying countries or regions with negative or positive price differentials.

The present analysis is based on simple econometric models that do not intend to be forecasting instruments. The proposed models have only the objective of checking for statistical evidences that ships built in some countries or regions tend to get prices higher or lower than others do. The models have second hand price as dependent variable and deadweight, age, indexes of earnings and newbuilding prices, LIBOR, and dummy variables representing the building country or region as regressors. Models specific for tankers, bulk carriers and containerships were estimated. The data covered the period from 2003 to 2014.

The analysis has evidenced that, in general, the effect of the origin of the ship on the second hand price is statistically significant.

For example, bulkcarriers built in Japan or in South Korea tend to get higher prices than ships produced elsewhere. In the case of tankers, the only significant evidence is that the Korean ships tend to be more valuable than the European ones. For containerships, the analysis has indicated a positive differential for the Korean ships in comparison with non-Korean.

REFERENCES

Adland R and Koekebakker S. 2007. Ship valuation using cross-sectional sales data: A multivariate non-parametric approach. *Maritime Economics and Logistics* 9, 105–118.

Alizadeh A H and Nomikos, N K. 2003. The price-volume relationship in the sale and purchase market for dry bulk vessels. *Maritime Policy and Management* vol 30, n 4, 321–337.

Alizadeh A H and Nomikos, N K. 2007. Investment timing and trading strategies in the sale and purchase market for ships. *Transportation Research Part B* 41, 126–143.

Beenstock, M. 1985. A theory of ship prices. *Maritime Police and Management* vol 12, n 3, 215–225.

Beestock M, and Vergottis A. 1993. *Econometric modelling of world shipping*. Chapman and Hall, 1993, London.

Clarksons 2016 - Shipping Intelligence Network—www.clarlksonsnet.com

Glen D R. 1997. The market for second-hand ships: Further results on efficiency using cointegration analysis. *Maritime Policy and Management* vol 24, n 3, 245–260.

Hale C and Vanags H. 1992. The market for second-hand ships: Some results on efficiency using cointegration. *Maritime Policy and Management* vol 19, n 1, 31–39.

Kavussanos, M G. 1997. The dynamics of time varying volatilities in different size second-hand ship prices of dry-cargo sector. *Applied Economics* 29, 433–443.

Köhn S. 2008. Generalized additive models in the context of shipping economics. University of Leicester, PhD Thesis.

Kou Y, Liu L and Luo M. Lead-lag relationship between new-building and second-hand ship prices. *Maritime Police and Management* vol 41, n 4, 303–327.

Merikas, A G, Merika, A A and Koutroubousis, G. 2008. Modelling the investment decision of the entrepreneur in the tanker sector: choosing between a second-hand vessel and a newly built one. Maritime *Police and Management* vol 35, n 5, 433–447.

Pires Jr., F. C. M.; Cipriano, W. M.; Assis, L. F. 2011. Influência do país construtor no preço internacional de navios. *Revista de Literatura dos Transportes* v. 5, n. 1, p. 4–32

Pruyn J F J, Voorde E and Meersman 2011. H. Second hand vessel value estimation in maritime economic: A review of the past 20 years and proposal of an 20 years and proposal of an elementary method. *Maritime Economics and Logistics* 13, 213–236.

Strandenes S P 2002. Economics of the markets for ships. *The Handbook of Maritime Economics and Business*, Grammenos C TH Editor. Llloyd's of London Press, 186–202.

Tsolakis S D, Cridland C and Haralambides H E. 2003. Econometric modelling of second-hand ship prices. *Maritime Economics and Logistics* 5, 347–377.

White, H. A 1980. Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity. Econometrica v. 48, n. 4, p. 817–838.

Wooldridge, J. M., 2012. *Introductory Econometrics: A modern approach*. s.l.: South-Western Cengage Learning.