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RESEARCH ARTICLE

The Effect of Aging on Ship Values: An Econometric Analysis on Major Ship Types

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ABSTRACT

Ships are investments that require significant capital and therefore the factors affecting their value must be analyzed carefully. The study in the paper is determined to what extent the effect of age, which is one of the most influential factors in sales value, differs in terms of ship type. The reports including the ship sale activities cover the period between January 2013 and December 2019 and consist of 84 monthly reports. Regression analysis was performed as the sales price as the dependent variable, age, freight, and size as independent variables. According to the results, it was determined that the ship types whose value decreases the most due to the age change are those used in gas transportation, while the least affected ship type by age is those used in bulk transportation. In addition, it has been determined that the ship type most affected by freight is those used in gas transportation and that the ship type most affected by the size is those used in container transportation. It can also be said that the ship type with the lowest risk of investment is bulk ships and the ship type with the greatest risk is gas ships. It is hoped that these results provide important information especially for players conducting their commercial activities upon sale & purchase transactions in the market.

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Introduction

Ships are assets with high values and therefore, careful analysis is required when making investment decisions (Ma, 2020). Although the secondhand market is a liquid market compared to the newbuilding market (Pehlivanoğlu & İnce, 2018), it may take a long time for the ships to be sold under several market conditions. The most important factor determining this duration is the demand for the ship. However, the demand for the ship is actually related to the demand for

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the cargo carried by that ship since the maritime market has a derived demand structure (Vermeulen, 2010). As developments in the world economy affect the demand for commodities, the demand for shipping is also affected (Başer & Açık, 2019a). Ship types in the maritime market are often called according to the types of cargo carried, such as dry cargo, liquid cargo, gas, container, general cargo, etc. (Branch, 2007).

There are some important factors affecting the demand for these ships by investors. Stopford (2009) expresses these factors in terms of cargo type, ship operation type, and commercial philosophy. The type of cargo intended to be transported constitutes an important factor in the selection of the ship since it often means abandoning the transportation of other types of cargoes. While some ships provide flexibility in the choice of cargo, some ships do not. The type of shipping operation is related to how the investor is interested in evaluating the ship; long-term chartering, operating in the spot market or operating in a liner network. For example, if long-term chartering will be held, the needs of the charterer can be more prioritized, and if it will be operated in the spot market, short-term resale values can be considered. Commercial philosophy is about how shipping investor looks at the maritime business. This philosophy determines whether the invested ship is flexible or not and the risk-taking courage. Shipping costs per unit are low on specialized ships to carry a single cargo in maritime transport, but different types of cargoes are unlikely to be transported when there is no specialized cargo. In ships that can carry more than one type of cargo, the cost of transportation per unit is high, but they are less dependent on a specific cargo. Considering these factors, the ship investor can make his investment by choosing a specific ship type.

Ship investors can be divided into two groups; the investors who purchase ships for transport activities (operators), and the investors who, as asset-players (speculators), purchase and sell ships in a short period (Kavussanos & Alizadeh, 2002). Although the investor has bought his ship for transportation activities, he can sell his ship with such a high-profit rate when market conditions revive, he cannot earn this profit rate for years only with transportation activities (Açık & Başer, 2018). For this reason, each factor affecting the value of ships is of vital importance for investors. These factors are stated as new building price, order book size, freight rates, fuel prices, age, and ship size in the literature (Pruyn et al., 2011). As the cycles in the maritime market are irregular and difficult to predict, it is unclear how soon favorable market conditions can occur when an investor purchases a ship. Consequently, the time-related depreciation rate of the ship's value stands out as an important factor. Since the types of ships used in maritime transport have a heterogeneous structure among themselves (Dickie, 2014), time-related value losses are likely to differ by ship type. Therefore, it is of great importance for ship investors whether the impact of time on ship values differs or not. However, it has been observed that there is no comprehensive empirical study with a satisfactory data set size in the literature.

In this study is examined monthly sale & purchase reports between 2013 and 2020 and collected information on the included ships. The size of the sample used is 2741 bulk carriers, 1238 oil tankers, 678 container ships, and 195 gas carriers. Although is analyzed the impact of age on values by ship types as a basic research question, the scope of analysis is expanded using factors such as freight and ship size that affect ship value as variables. As a result of the analysis, it is found that there was a differentiation in the impact of age, but this differentiation was lower than impact other variables that affect ship value. It is hoped that these results will be useful for investors, regardless of their commercial purposes, in reducing the risks arising from uncertainty. In addition, it is thought that an original contribution has been made to the literature with a comprehensive data set. In the second section of the study, the relevant literature is reviewed, and the framework of the study is formed.

Literature Review

To enrich the content of this study, which examines whether the effect of ship age on the prices of different ship types varies or not, the studies examined the secondhand market from various angles investigated during the literature review. Pruyn et al. (2011) conducted a study in the form of a literature review on which variables are used in studies on the secondhand ship value recently. The researchers revealed that new building price, order book size, freight rates, fuel prices, age, and ship size variables were used, and significant results were obtained mostly. However, to handle the market multidimensional, other related studies that are thought to be original are also included.

The purpose of the use of ships is one of the biggest determining factors in determining their size. According to these purposes, the size of the ships and their number in the market are formed. Some ships are used to transport volumes of trans-ocean cargo and their number is very low (Capsize, VLCC, etc.) while some ships are used to transport small volumes of cargo over short distances and their number is quite high (Handysize, Panamax, etc.). Based on this situation, it can be questioned whether the size of the ship makes a difference in the secondhand price volatility. Kavussanos (1997) conducted a study examining the effects of the size of secondhand dry bulk cargo ship on price volatility. According to the results of the study, which uses ARCH model, the price of small size ships is more volatile than the price of large size ships. This could possibly be because the transaction volume is higher on smaller vessels. However, papers related to the price & transaction volume indicated opposite inference. Alizadeh & Nomikos (2003) focused on the relationship between the prices in the secondhand dry bulk ship market and the trade volume in their research. In this research, a number of different methods are used to investigate the structure of the price-volume relationship in the sale & purchase markets for different sizes of dry cargo ships. The results revealed that price volatility can be a useful way to make predictions on trade volume, as high capital gains trigger more transactions in the market. On the other hand, the impact of trade volume on price volatility was found to be negative. Increased sale & purchase activities in the market supported price stability. Syriopoulos & Roumpis (2006) expanded the scope of the same subject and explored it in both dry bulk cargo and tanker markets. Their results are identical to those of Alizadeh & Nomikos (2003) and confirmed their accuracy in defining the market structure.

One of the factors that can affect the value of secondhand ships the most can be said to be the new building prices. In times of alive market, secondhand ship prices rise high and close new building prices. New building prices affect the demand for secondhand or new ships. However, the question of which market leads which one is an important research question. Kou et al. (2014) conducted research on lead–lag relationships between the second hand and new build ship prices. As a result of the research, they found that there is an inverse lead-lag relationship between dry bulk and tanker ships. While secondhand ship prices in the dry bulk cargo sector led to the prices of new building ships, the findings in the tanker cargo market point to the opposite. The main reason for this distinction was the differentiation in competition and commercial philosophy in the sectors.

Significant incomes in the maritime market are not only provided by transportation. Simultaneously, the sale & purchase market offers opportunities for shipowners to generate high incomes. In fact, some investors earn a significant income by building their business philosophy solely on sale & purchase activities. These types of investors may have different characteristics, and the effect of this differentiation on secondhand prices may be different. Alizadeh et al. (2017) considered two major heterogeneous investor groups in the secondhand ship markets momentum and contrarian investors. While the first group determines their investment strategies by following the market momentum and trends, the second group determines their strategies by believing in the circularity in the market. With the cycle-based approach, they purchase when prices fall below the fundamental value and sell when prices rise above the fundamental value. As a result of their analysis using the heterogeneous agent model, the authors determined that an increase in the participation of momentum investors tends to increase price volatility. However, high demand from contrarian investors has been said to reduce price variability.

Heterogeneity can be seen not only in investors but also in ship-pricing periods. The effect degree of the factors that affect the value of the ship may differ in different periods. In the study by Merika et al. (2019), heterogeneity in the prices of dry bulk ships was investigated by applying the quantile analysis using the data of 5,591 ships that were traded in the dry bulk market. They used vessel size, age, new building price, scrap value, LIBOR, the time charter level, and technology dummy variable. When the researchers applied the analysis of prices in different distribution regions, they found that the factors that most affect heterogeneity were the age of the ship, 3-month LIBOR, and annual charter level.

Since maritime transport has a derived demand structure, demand for goods transported may affect ship value. With the demand-led approach, under the assumption that the price of a goodwill increase/decrease when the demand for it good increases/decreases, significant results were obtained when the relationship between the commodity price and the ship value is analyzed. Başer & Açık (2019b) focused on the relationship between the secondhand values of capesize ships and the iron ore price, which is the most basic load of these ships. In this direction, the asymmetric causality test was used to determine the causality relationship between the shocks contained in the series. As a result, negative shocks in iron ore were found to be the cause of the negative shocks in the 5-year-old capesize vessel value, and increasing shocks in the commodity price trigger the increasing shocks in the value of the vessel. So, following the commodity prices while implementing investment strategies can reduce the risks arising from uncertainties and even provide critical profit opportunities.

Our study differs from the studies in the literature in that it covers many ship types. In our research, separate models are estimated for dry bulk, tanker, container, and gas type vessels. Although we have an age-focused research question, variables such as freight and ship size are also included. Thus, both the explanatory powers of the models increase and a comparison between other factors affecting the value becomes possible. In the next section, the method we used is introduced.

Methodology

In this study, we decided to use linear regression analysis to determine the relationship between variables. Regression analysis is one of the most widely used statistical analyses and its application areas cover many fields such as medicine, biology, agriculture, economics, engineering, sociology, geology, etc. (Yan & Su, 2009). This method examines functional relationships between variables to reveal statistical and theoretical relationships (Chatterjee & Hadi, 2015) and it consists of many different kinds according to the purpose of use, variables, and data types. The paper is used multiple linear regression analysis in our study, which can be expressed as in Equation (1):

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_i X_i + \varepsilon \qquad (1)$$

In Equation (1), Y is the dependent variable while X's are independent ones. The variable ε, on the other hand, refers to the unexplained parts of the model, namely, the residuals (Gordon, 2015). This equation is defined as multiple linear regression because it is constructed with more than one independent variable (Allen, 2004), if it included only one independent variable it would be expressed as simple linear regression (Gaurav, 2011).

After the regression model is estimated, situations such as whether the model is significant, how much the independent variables explain the dependent variable, which independent variable has a significant effect, whether the effect of the independent variable is negative or positive, and how much the effect of the independent variable is can be determined. The β's obtained from the model contain important information about the effect of independent variables. They show to what extent the independent variables affect the dependent variable and in which direction this effect is (Esquerdo & Welc, 2018). When there is more than one independent variable in the model, the βs enable us to determine the effect of each independent variable separately (Archdeacon, 1994).

After the model has been estimated, some assumptions should be tested before interpreting the coefficients such as the conditional mean of ε is zero, coefficient constancy, which reveals that both β and ε are fixed over the sample period, serial independence in the disturbances of ε, and a distributional assumption of normality for ε (Pagan & Hall, 1983). Obtaining appropriate findings from the assumptions supports the validity of the model and interpretation of the results becomes more reliable (Menard, 2002). In case some of these assumptions are not met, the model can be used after applying some correction methods.

The regression model in the study is constructed as presented in Equation (2):

$$\ln SP_i = \ln \beta_0 + \beta_1 \ln AGE_i + \beta_2 \ln FREIGHT_i + \beta_3 \ln SIZE_i + \varepsilon_i \qquad (2)$$

where ship sale price variable (SP_i) is dependent variable while variables age (AGE_i), freight ($FREIGHT_i$) and size ($SIZE_i$) are independent. The aim was to obtain significant findings by estimating this model for selected ship types in the data sample and comparing their results. A log-log model was used in the regression coefficient estimation due to the opinion that in this way it is possible to compare the impact of age on ship value based on ship types. In the next section, the dataset used in the study is introduced and analyzed.

Data

The data used in the study were obtained from various available and relevant sources. Information including characteristics such as age, size and price of the ships was obtained from the Athenian Shipbrokers Monthly Sale & Purchase reports (Athenian Shipbrokers, 2020). The reports cover the period between January 2013 and December 2019 and consist of 84 monthly reports. Bulk, tanker, container, and gas types of ships are included in the sample. Ship type classifications are handled as in market reports. In addition to these ship types, Tween/MPP, Reef, RO-RO, Ferry, Cruise vessels are also available. However, statistically, they were excluded from the study because of their low volume.

The indices representing the freight levels according to the ship types consist of the Capital Link indices (Capital Link, 2020). The freight indices consist of the arithmetic average of the daily values in the month corresponding to the report month. Ship group types used in the study are dry bulk, tanker, container, and gas vessels. Capital Link Drybulk index for dry bulk ships, Capital Link Tanker index for tanker ships, Capital Link Container index for container ships, and Capital Link LNG/LPG index for gas ships are used as freight indices.

Descriptive statistics for bulk carriers are presented in Table 1. There are 2741 ships in the sample that make up the dry bulk ship type. This sample size is the largest of all ship types. The average age of this ship type is 10.8 years, and the average price is $ 13.6 million. In terms of size, DWT (Deadweight Tonnage), which expresses the cargo carrying capacity, is used and the ships sold are on average 67591 DWT.

The oil tankers' descriptive statistics are presented in Table 2. In the period under consideration, 1238 ships were sold. This tanker group includes crude oil, product, and chemical tanker ships. This type of ships have an average value of $23.8 million and their average age is 11 years. The size of the oil tankers is indicated by DWT as bulk carriers, and the tanker ships sold have an average size of 81440 DWT.

Table 1. Bulk market

	Price	Age	Freight	DWT
Mean	13.65879	10.85553	632.5176	67591.41
Median	10.00000	10.00000	666.2705	56734.00
Maximum	423.0000	40.00000	1051.693	402303.0
Minimum	0.450000	1.000000	152.7395	75.32100
Std. Dev.	16.81649	6.697172	234.3722	46659.10
Skewness	11.53961	0.449319	-0.390449	1.930111
Kurtosis	224.6174	2.649702	2.584860	8.183200
Jarque-Bera	5670092.	106.2432	89.32723	4770.125
Probability	0.000000	0.000000	0.000000	0.000000
Observations	2741	2741	2741	2741

Note: Source: Athenian S.A. (2020), Capital Link (2020)

Table 2. Tanker market

	Price	Age	Freight	DWT
Mean	23.80979	11.06785	1561.524	81440.87
Median	15.00000	11.00000	1204.705	47157.00
Maximum	685.0000	42.00000	3026.002	320051.0
Minimum	0.400000	1.000000	579.6037	1252.000
Std. Dev.	37.83948	6.161417	816.1023	87020.87
Skewness	9.958469	0.442944	0.409078	1.603877
Kurtosis	153.2586	3.632365	1.585152	4.633672
Jarque-Bera	1185093.	61.10995	137.7881	668.4461
Probability	0.000000	0.000000	0.000000	0.000000
Observations	1238	1238	1238	1238

Note: Source: Athenian S.A. (2020), Capital Link (2020)

Descriptive statistics for container ships are presented in Table 3. There are 678 container ships in our sample. Their average value is $13.8 million and their average age is 11.5 years. In terms of size, twenty-foot equivalent unit (TEU) is used differently from dry bulk and tanker ship types because it expresses the capacity better for container ships. The vessels in the sample are on average 2823.3 TEU in size.

Table 3. Container market

	Price	Age	Freight	TEU
Mean	13.88676	11.54277	1210.961	2823.363
Median	7.950000	11.00000	1252.019	2452.000
Maximum	280.0000	23.00000	2123.941	13806.00
Minimum	0.600000	1.000000	528.2529	272.0000
Std. Dev.	23.40684	4.618417	515.5810	2180.023
Skewness	6.336644	-0.034809	0.041419	1.914184
Kurtosis	58.02750	2.671722	1.445006	7.699473
Jarque-Bera	90079.03	3.181323	68.50255	1037.946
Probability	0.000000	0.203791	0.000000	0.000000
Observations	678	678	678	678

Note: Source: Athenian S.A. (2020), Capital Link (2020)

The gas carriers' descriptive statistics are presented in Table 4. In our study, the lowest sample belongs to this ship type and consists of 195 ships. Their average value is $35 million, and their average age is 14.9 years. Unlike other ships, cubic meter (CBM) values are used in terms of size, because it is a better measure for gas transportation. The average size of the vessels in the sample is 46463.3 CBM.

Table 4. GAS market

	Price	Age	Freight	CBM
Mean	35.06728	14.93333	2576.999	46463.37
Median	19.00000	15.00000	2715.561	22149.00
Maximum	310.0000	35.00000	4367.142	170234.0
Minimum	0.900000	1.000000	1303.960	1725.000
Std. Dev.	50.29824	8.614341	806.6976	48494.49
Skewness	2.761786	0.142159	0.169890	0.901438
Kurtosis	11.05677	1.962965	1.664295	2.652553
Jarque-Bera	775.2981	9.394753	15.43391	27.39005
Probability	0.000000	0.009119	0.000445	0.000001
Observations	195	195	195	195

Note: Source: Athenian S.A. (2020), Capital Link (2020)

Age distribution charts of the ships sold are presented in Figure 1. According to the chart, it can be said that the sales transactions of old ships in the dry bulk and tanker markets are very low. Sales of young and middle-aged vessels are quite intense. In the container market, both young and old ships have low sales. In the gas market, sales of middle-aged vessels are low, while sales of young and old vessels are relatively high.

To reveal the linear relationships of the independent and dependent variables in the dataset, the distributions in the XY chart were examined and the regression line and equations of their relations were revealed. In the visuals presented in Figure 2 for tanker and bulk ships and Figure 3 for container and gas ships, the linear relationship between the independent variables and the dependent variable can be clearly seen. There is a naturally negative relationship between the age and the sale price, as the age increases, the value of the ship decreases since the remaining economic life of the ship decreases. On the other hand, the relationship of freight and size variables with the sales price is positive. However, their slopes are flatter than the age sample. The main reason for this is, of course, their effects are examined regardless of age, which can be regarded as the most important factor in the ship value. In this respect, the ability of the freight variable alone to explain the sale price is very low considering R^2 values. The next section presents the results obtained by estimating the regression equation for each ship type.

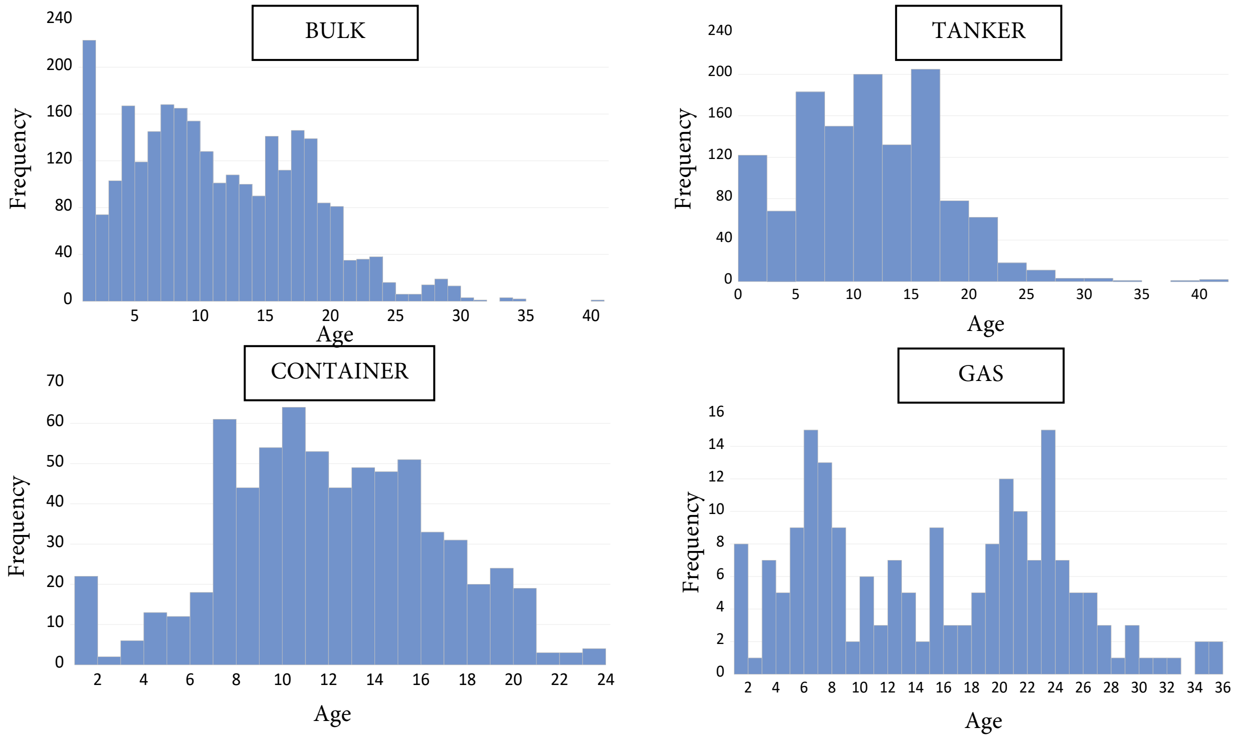

Figure 1. Age distribution in the markets (Source: Athenian S.A. (2020))

Table 5. Results of regression model (Probabilities are shown in square brackets "[]")

Model	Tanker	Tanker Robust	Bulker	Bulker Robust	Container	Container Robust	GAS	GAS Robust
Age	-0.59	-0.59	-0.53	-0.53	-0.56	-0.56	-0.72	-0.72
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Freight Index	0.11	0.11	0.46	0.46	0.26	0.26	0.58	0.58
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Size	0.44	0.44	0.53	0.53	0.77	0.77	0.55	0.55
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Constant	-1.59	-1.59	-5.42	-5.42	-4.31	-4.31	-5.471	-5.471
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
F Stat.	1125	1125	2966	2966	457	457	206	206
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
R-Squared	0.73	0.73	0.76	0.76	0.67	0.67	0.76	0.76
Adj. R-Squared	0.73	0.73	0.76	0.76	0.66	0.66	0.76	0.76
Durbin-Watson	1.48	1.48	1.19	1.19	1.04	1.04	1.65	1.65
Autocorrelation	Yes	-	Yes	-	Yes	-	Yes	-
Heterosc.	Yes	-	Yes	-	Yes	-	No	-
Normality (JB)	1170	-	14238	-	264	-	1159	-
	[0.000]		[0.000]		[0.000]		[0.000]	
Wald F Stat.	-	496	-	563	-	134	-	87.28
		[0.000]		[0.000]		[0.000]		[0.000]

Finally, the model estimated for gas carriers is significant and has a good R-squared value of 0.76. Since autocorrelation was detected in the residuals of the model, HAC correction was applied and the new results were presented as Gas Robust. 1% change in age causes 0.72% change in sale price, 1% change in freight causes 0.58% change in sale price, and 1% change in size causes 0.55% change in sale price. After the regression models were estimated for all ship types, the coefficients are visualized in Figure 4 to make the evaluations more appropriate.

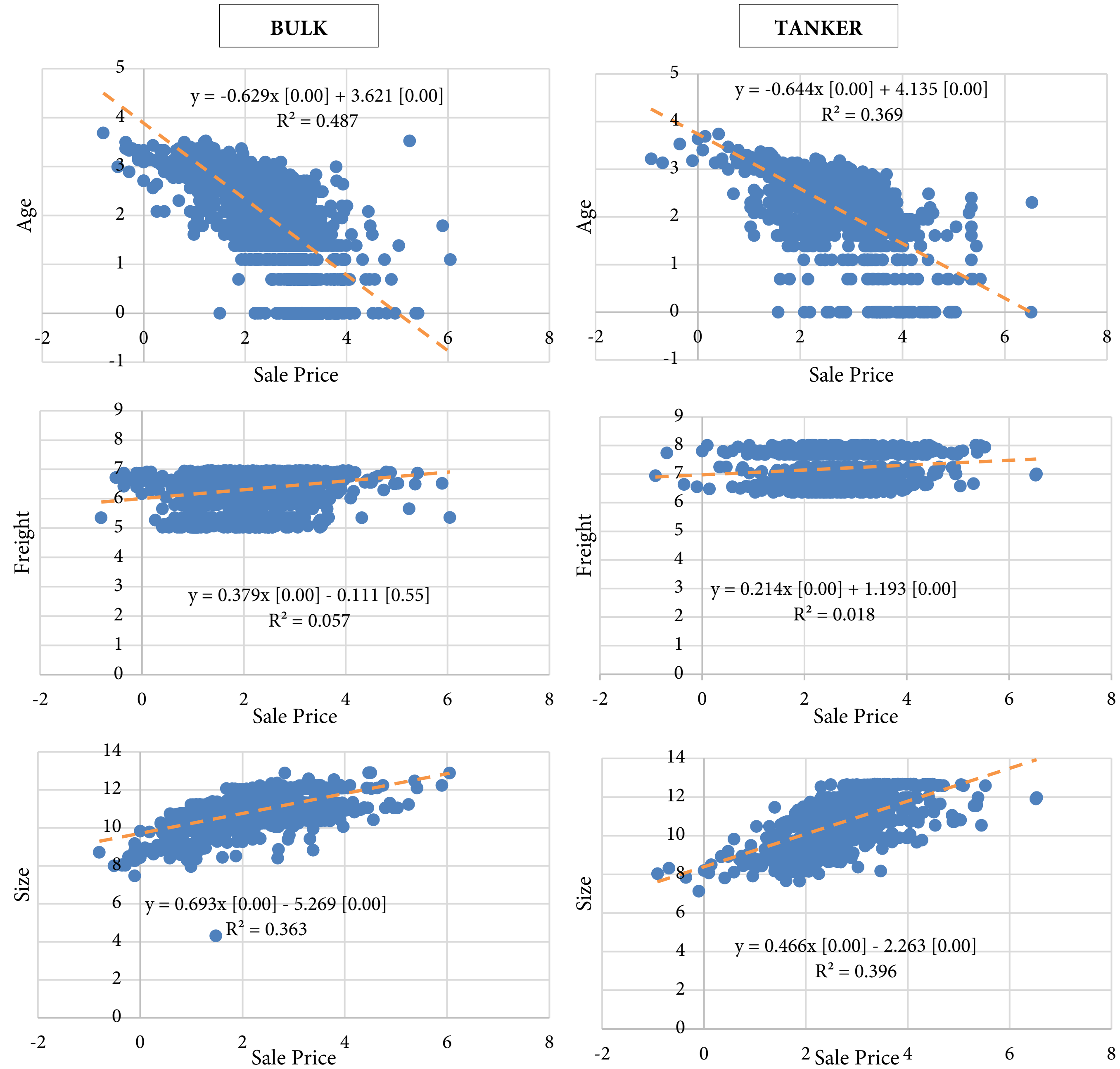

Figure 2. Relationship between dependent and independent variables in bulk and tanker ships (Probabilities are shown in square brackets "[]")

Results

The logarithms of the series were taken before the regression analysis. In this way, log-log models were established, and percentile changes indicated by the ship values against 1% changes in independent variables were determined. Multiple linear regression according to the expression 2 for each ship type is performed in EViews 10 econometric software. After the models are estimated and residuals are checked, Huber-White (White, 1980) correction is applied in the case of heteroscedasticity, HAC (Newey & West, 1987) in the case of autocorrelation, and HAC corrections in the case of both heteroscedasticity and autocorrelation.

Statistical results of the regression models for each ship type are summarized in Table 5. Theoretically, the signs of the variables were obtained logically. The coefficients of the age variables were obtained negative in all ships. As the ship ages, its technology gets old and its remaining economic life decreases. In addition, the signs of freight and size variables were obtained positive. It is normal for ship values to be higher in lively market conditions, as shipowners may be willing to pay higher prices to ships to take advantage of current and future higher revenue opportunities. In addition, since the increase in the size of the ship means more carrying capacity, the ships can naturally find purchasers at higher prices.

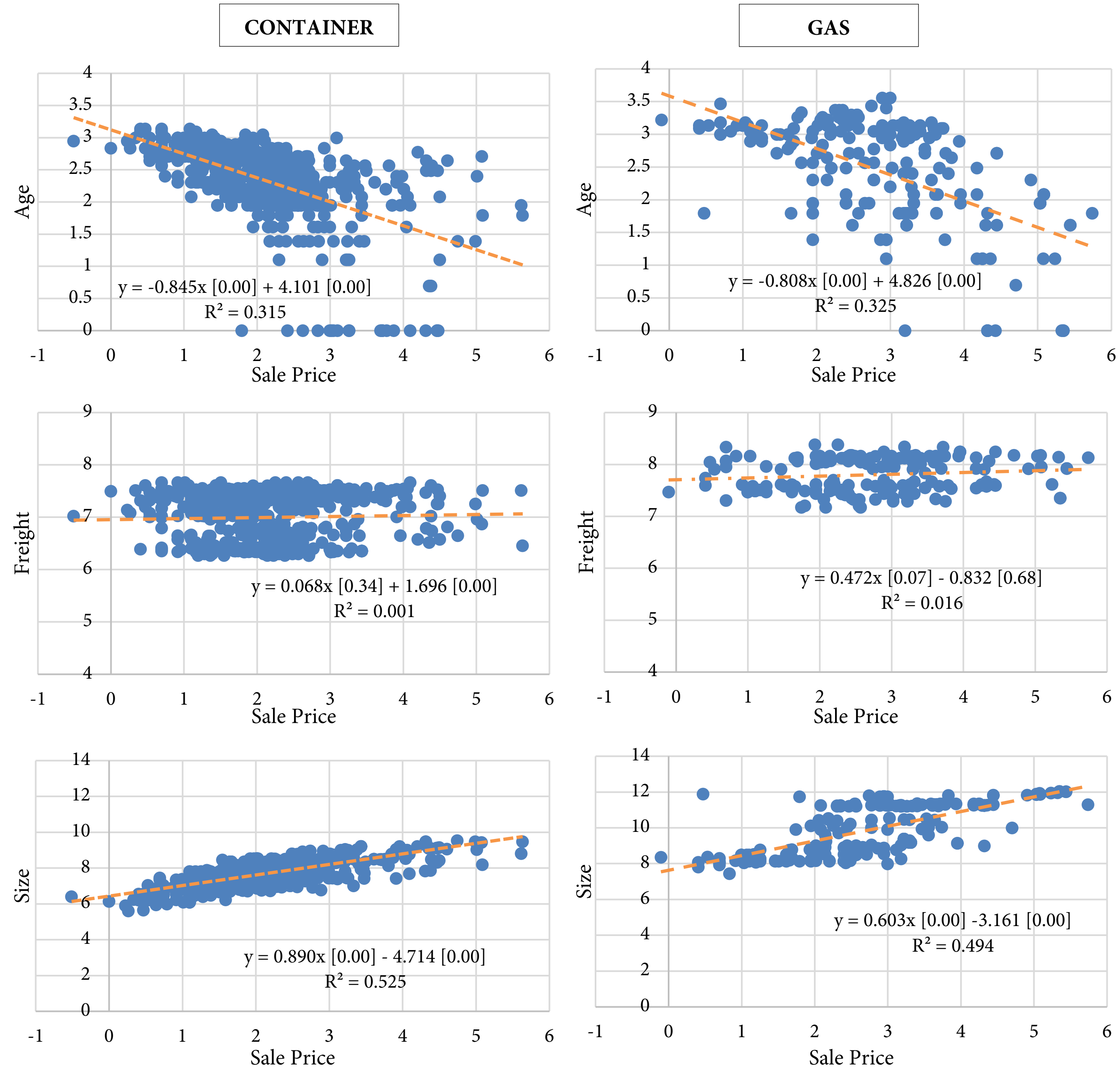

Figure 3. Relationship between dependent and independent variables in bulk and tanker ships (Probabilities are shown in square brackets "[]")

The estimated model for the oil tankers is significant and has a satisfactory R-squared value of 0.73. However, autocorrelation and heteroscedasticity were detected as a result of the diagnostic tests performed on the residuals of the model. For this reason, standard errors were recalculated by applying HAC correction and the new results are presented as Tanker Robust. 1% change in age causes 0.59% change in sale price, 1% change in freight causes 0.11% change in sale price, and 1% change in size causes 0.44% change in sale price.

According to the equation results estimated for bulk carriers, the model is significant and has a good R-squared value of 0.76. However, there is autocorrelation and heteroscedasticity considering diagnostic tests on residuals. For this reason, HAC correction has been applied to the model, and results are presented as Bulker Robust. 1% change in age causes 0.53% change in sale price, 1% change in freight causes 0.46% change in sale price, and 1% change in size causes 0.53% change in sale price.

The estimated regression model for container ships is significant and has a satisfactory R-squared value of 0.67. Diagnostic test results applied to residuals showed autocorrelation and heteroscedasticity in the model. Therefore, HAC correction has been applied and the results are presented as Container Robust. The results showed that 1% change in age causes 0.56% change in sale price, 1% change in freight causes 0.26% change in the sale price, and 1% change in size causes 0.77% change in sale price.

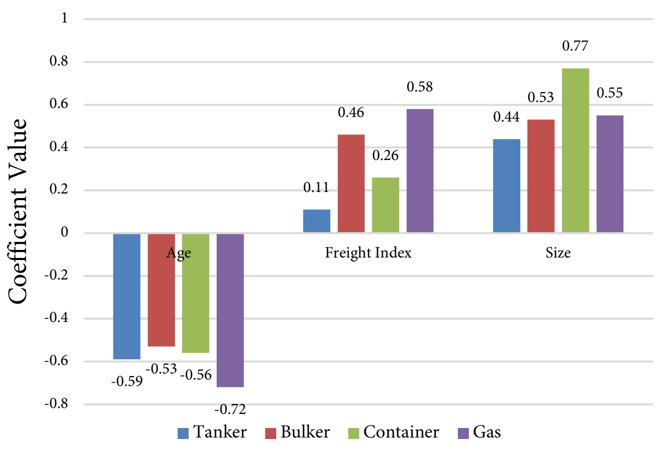

Figure 4. Comparison of the coefficients

According to the results, the ship type whose sale price is the most affected in terms of age stands out as gas carriers. A 1% change in age causes a 0.72% change in ship value. Next comes oil tankers and container ships, and the least affected one is the bulk carrier. It may be thought that the reason for this is the increased maintenance and operational costs of the vessels depending on age. It can also be said that the operational processes of tanker and gas vessels may have a more corrosive effect on these ships. To understand another possible cause, we should refer to Karl Marx's concept of moral depreciation. The fact that the new gas ships launched on the market are equipped with more advanced technologies compared to the old ones causes a more lowering effect on the prices of the old ships, which means that gas ships be exposed to moral depreciation more.

When the coefficients of the freight variable are examined, it is determined that there are big differences compared to age. In this variable, gas carriers come to the fore as ship type which is most affected by changes in freight rates. Next comes to bulk carriers and container ships and the least affected ship is oil tankers. The reason may be less affected by the freight due to their use as oil storage (Başer & Açık, 2018). The rate of response to freight rates may be low as demand for ships changes according to the changes in oil prices rather than freight levels. In addition, because people who want to transport and store oil prefer to charter tanker ships rather than purchase, the response of ship values to freight rates may be low.

In terms of size, container ships are the most affected ship type and have a very high value compared to other vessel types. This may be because container ships are used to transport high-value cargoes. The demand's response to freight may be limited, as the rate of transportation cost to cargo value is low. This structure may cause increases in earnings per unit and have led to the highest coefficient being observed in container ships. Bulk and gas carriers have very close coefficients, while the least affected ship was determined as oil tanker ships. Based on the use of oil tankers as storage, it could be expected to be the ship type most affected by size. However, in this case, the inventory cost brought by storing very large amounts of oil may be effective.

Discussion

Market cycles in the shipping industry are directly related to world trade volume since nearly 90% of world trade in terms of tonnage is carried out by ships (Rodrigue, 2013). Therefore, maritime transportation is very sensitive to economic ups and downs, which means that markets in maritime transportation have volatile structures and various regimes with different characteristics (Tarı & İnce, 2019). Under these circumstances, investments in the maritime industry are risky. Investors need to be able to accurately calculate market-related variables to minimize risks. Making sale & purchase decisions at the right time in the market cycle results in very profitable returns.However, just reading the market correctly may not be enough to gain profitable opportunities in the ship sale & purchase market. Because many different types of ships are operated in the secondhand market and there can be great heterogeneity even between ships of the same type. Our study can contribute to ship investors, who are grouped by Alizadeh et al. (2017) as operator, momentum, and contrarian, to follow the right strategies. As a result, although the operators maintain their commercial activities through transportation, they can earn an amount of income from ship sales in the peak periods of the market that they could not earn for years with transportation activities. Their commercial philosophies are important, that is, they will carry which cargo with which ship type, on which route, and in what amount, but it is also advantageous to consider the differences in the loss of value in the types of ships. As those in the momentum group follow market conditions, the loss of value due to age is important. In addition, the findings are valuable as we include the effect of freight rates in our models in addition to age. Contrarians, on the other hand, hope to make huge profits by aiming to sell at the highest point and to purchase at the bottom of the market, but the cycles in the maritime market are very irregular and heterogeneous. Similar to a cycle is unlikely to be seen in the further periods. Also, the lengths and sizes of the cycles are very different from each other. There have been recessions in the markets for a long time at some periods. It is of great importance that they consider the differentiation in value losses in different kinds of ships over time, especially for investments that coincide with such depressed periods, at least for loss-minimization.

When the value losses due to age are considered, it is seen that the highest loss of value is in the gas type ships. If investors do not have the intention of making satisfactory profits from transport activities, such ships may be more likely to suffer from delays in sale & purchase transactions. On the other hand, they have the highest rate of gains in value due to freight rates. Considering this gain and the scarcity of sale & purchase transactions in our sample, it can be said that they are risky ships for investment, although there is a high probability of high return. The smallest loss of value due to age was detected in bulk ships. These types of vessels can be considered low-risk vessels for investment because as can be seen from our sample, there are several sales & purchase transactions and the loss in value due to age are the lowest. In addition, when considered with age, the value gains due to freight are quite high, and this may indicate that they are the suitable ship types for investors hoping to make big profits from their sale & purchase transactions. During peak market periods, their sellout can provide great profit opportunities. On the other hand, in tanker type ships, the value loss due to age is relatively high. In addition, value gains arising from freight have the lowest rate. This may be due to their being more sensitive to oil prices and being used as a storage house when necessary. In this respect, it seems very difficult to follow the maritime cycles and to make a profit by selling the ship during the peak periods of the market. On the other hand, in container ships, the value loses due to age is average and they stand out with their high coefficient in size. Considering the market structure of container transportation, this situation is reasonable, since the space occupied by the ship is more important than the content of the cargo in the container and the source of income is determined accordingly. In addition, since there is little concern for reaching somewhere and looking for another cargo contrary to bulkers, the cost increase due to speed may be low and the importance of size increases. In this respect, it is thought that original contributions are made to the literature and practical field.

In future studies, the scope can be expanded by including different variables representing market conditions during the trading of ships. Although freight rates represent the market as an indicator of income for ship investors, interest rates that show the cost of the capital required for investment are also an important factor. The return on freight rates and the cost of interest rates can be decisive in ship sale & purchase decisions. For example, in the study by Açık et al. (2020), it was determined that interest rates are also effective in new ship order and ship demolition decisions. These rates play an important role in balancing the transport capacity in the market. In addition to interest rates, shipbuilding costs can also be included in the analysis. Thus, a substitute option for purchasing the secondhand ship is included in the model. However, due to a large number of heterogeneous ship types in the dataset, it is difficult to add shipbuilding costs for all of them, and accessing such data requires bearing serious costs. Nevertheless, if such data can be obtained, it will greatly contribute to the development of the analysis.

Conclusion

We determined whether the effect of age, which is one of the most important factors affecting the values of ships, differs according to some major commercial ship types. Our results reveal that the effect of age differs slightly according to the ship type and it is greater in specialized ships. In the effects of freight rates and ship sizes, the differences between coefficients of ship types are higher. Studies have been conducted on ship valuations and the factors affecting these valuations in the literature. However, the lack of a study in the literature in which ships are analyzed based on market data by considering their ages, supports the originality of our study. It is hoped that our findings can guide ship and cargo owners in terms of their commercial strategies by revealing the risks arising from aging.

Compliance with Ethical Standards

Authors' Contributions

OHG designed the study, AA performed the statistical analysis, SÖB and KÖE reviewed the related literature. All authors read and approved the final manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical Approval

For this type of study, formal consent is not required.

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