Modeling the Investment Decision of the Entrepreneur in the Tanker Sector: Second Hand Purchase or New Building?

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Abstract

This paper argues that in the investment decision of the entrepreneur (if he should purchase a second hand vessel or build a new one), what matters is not the second hand price and its determinants per se, but instead the ratio (SP/NP) second hand price over the new building price and its movement. We investigate the determinants of this ratio across different ship sizes in the tanker sector and show that it can be used as an effective tool in decision making as well as in asset evaluation .
W e employ monthly data between 1995 and 2006 for four different ship sizes, VLCC, Suezmax, Aframax and Handymax in the tanker sector and implement a GARCH(1,1) model.
It is found that the perception of riskiness directly impacts upon the ratio (SP/NP). An increase in freight volatility leads to an increase in the risk premium across ship sizes and therefore the ratio under examination rises.
Furthermore, in the case of Suezmax, the mean ratio is strongly affected by the volatility of shocks to this ratio.
Overall we claim that the cyclicality of the shipping sector together with expectations formed by the agents operating in it (the entrepreneur, the ship-owner and the broker), determine the movement of the ratio and hence the decision of the entrepreneur.

Key Words
Investment decision, Second-Hand price, New-Building price, Freight volatility, Perception of Risk
EFM Classification Codes

310, 210, 530

Introduction

Numerous studies have been conducted on the relationship between price and trading volume in financial markets and in recent years this relationship has also been under investigation in real asset markets, like merchant ships. Even though it is recognized that a ship is a real asset, all studies have looked at this relationship from the demand side alone (i.e. the determinants of price variability in terms of volume etc).

The market for second hand ships has distinct features and plays an important role in the shipping industry as a whole. It contributes significantly to the competitiveness of the industry since through it, the purchase and sale of ships is greatly facilitated.

The ship by nature is an asset and in the second hand market considerable profit opportunities arise where the investor can buy low and sell high known as 'asset play'. The crucial factor is the timing of entering the market, because of the cyclicality feature.

The people that usually assess a ship's value are the brokers which employ a number of empirical and technical criteria. This research paper aims to provide them with a useful tool.

Specifically, this study attempts to build the functional relationship between second hand price over new building price and its main determinants in the tanker sector.This way, we can treat the dependent variable (SHP/NBP) as

a) a tool for the initial investment decision of the entrepreneur and b) as a prediction mechanism for the value of the ship for loan financing purposes.

The aim of this paper is to investigate for the first time, what determines the variability in the ratio second hand tanker-ship prices over the new building price.

There are three questions that this paper attempts to shed light on.

The first is, based on economic theory and industry related evidence, to construct the functional relationship between the ratio under investigation and its main determinants. This way, the variability and the level of the asset value is examined with respect to factors that are measurable and that the decision maker should seriously take into account, before acting.

The second is, to quantify this relationship for the different categories of vessels in the tanker sector and compare and contrast the results. Estimation of such relationships is of considerable interest to academics and practitioners alike since modeling the behavior of the SHP/NBC has important applications for the initial investment decision of the ship and the forecasting of its future asset value.

The third is to investigate whether there is a relationship between the volatility of the aforementioned ratio and market activity in the tanker sector.

Literature Review

There is a significant number of studies in the literature investigating the determinants of the second hand price of ships. Beenstock(1985) and Beenstock and Vergottis(1989a,1989b,1992,1993) argue that the supply and demand framework is not appropriate for determining ship prices, since a ship is a real asset with a long life. So they adopt the Markowitz portfolio theory and state that the share of ships in total world wealth varies directly with the expected return on ships as capital assets and is inversely related with alternatively investments. Therefore asset prices depend on expectations. Further, they assume that new and second hand ship prices are perfectly correlated , so new and second hand ships are the same asset, differ only in age. They introduce the new building price in their model as an explanatory variable.

Strandeness(1984,1986) considers second hand prices as a weighted average of short and long term profits. The second hand price depends on expectations about the future of the shipping industry worldwide. The second hand market is fully correlated with the new building market.

Another interesting study is the one by Veenstra(1999). He established that second hand ship prices for various types and ship sizes can be explained in terms of a time charter rate, newbuilding as well as scrap prices. He then tests for long run cointegrating vectors.

Hale and Vanags(1992) and Glen(1997) test the hypothesis whether the market for ships is efficient through a dynamic framework of second hand tanker and dry vessel prices. They conclude that there is long run market efficiency in the shipping industry.

Kavussanos(1996,1997) examines the dynamics of volatilities in the tanker and dry vessel sectors. He finds through ARCH modeling that the prices of small vessels are less volatile than larger ones and the nature of this volatility varies across sizes.

Tsolakis et.al (2002) analysed the cyclical nature of second hand ship prices aiming to describe and forecast cycles and to evaluate policies.Newbuilding prices and time charter rates was found to have a positive effect on second hand prices for all types of ships (Panamax and Capesize Bulkers,Panamax,Aframax,Suezmax and VLCCs) except handy bulk carriers and tankers. The new building price variable has a higher impact on second hand prices than the time charter rate one.

Alizadeh and Nomikos(2002) investigated the relationship between second hand prices and trading activity for dry bulk vessels. They found that price changes are useful in predicting trading volume, which suggests that higher capital gains encourage more transactions in the market. It was also found that increases in trading activity lead to a reduction in market volatility. This finding is in contrast to the results from a number of similar studies on financial markets, Gallant et.al(1992),Gervai et.al(2001) Lee and Rui(2002)and Chen et.al(2001). They indicated the existence of a positive relationship between price change volatility and volume. Furthermore, a causal relationship was derived between trading volume and price changes although the direction of causality differs depending on the market under investigation.

The contribution of this paper to the literature can be seen in a number of ways.

First, the behavior of second hand prices in the shipping sector is related not only to trading activity but to a number of other fundamental variables, important in the decision making of the ship owner. A low SHP/NBP ratio implies that ship owners expect in the future a strong market and can afford to wait for another two or three years until the delivery of the new vessel, under the assumption that current freight market is not on its peak. Regulations and quality standards for ships caused the gap of the condition of hull and tanks between a second hand vessel and a new built vessel to be eliminated, so the choice of acquisition between the two categories sets a dilemma as 5 year old ships can be delivered really soon but the owner of new vessel's contract has to wait for a couple of years due to the increased activity in the shipyards in the last years. So for the current strong freight market we expect that our ratio will be higher, which implies that freight rate has positive impact to our ratio, a result that will be proven in the next section. Using this ratio as depended variable related to transaction volume in the second hand market and the freight rate we obtain a decision model for the choice between buying a modern vessel or shipbuilding.

Second, the results of our model are compared among the different ship sizes in the tanker sector and useful comparisons or contrasts can be made. Third, the ratio under investigation can be used effectively in decision making as well as asset evaluation by the owner, the entrepreneur or the broker.

Data set

Monthly times series data was collected for the years 1995 to 2006 from Clarkson Research Services. Specifically we collected second hand tanker prices for five year old ships, new tanker prices, time charter rates for 1 year contracts of modern vessels, transaction volume for each size (Handysize, Aframax, Suezmax, Vlcc). We also collected crude oil prices as a trade index and we used LIBOR as a measure of entrance in the tanker sector or for further expansion. Data manipulation and model estimation were conducted with the statistical package Eviews 5. All series were checked for stationarity through the ADF unit root test

Table 1: ADF-test, Variables in levels

Variable	**VLCC**	**Suezmax**	**Aframax**	**Handysize**
SHP/NBP	-2.54	-2.61	-2.29	-1.64
Tcrate	-1.88	-2.43	-2.01	-1.82
Volume	-2.78	-3.71	-4.08	-2.89
Risk	-4.29	-4.65	-4.55	-4.14
Crude	2.38	2.38	2.38	2.38
LIBOR	-1.62	-1.62	-1.62	-1.62
CGT	-1.02	-0.26	-0.57	0.29

MacKinnon critical values for rejection of hypothesis of a unit root at 1% is -3.48, at 5% is -2.88, at 10% is -2.58.

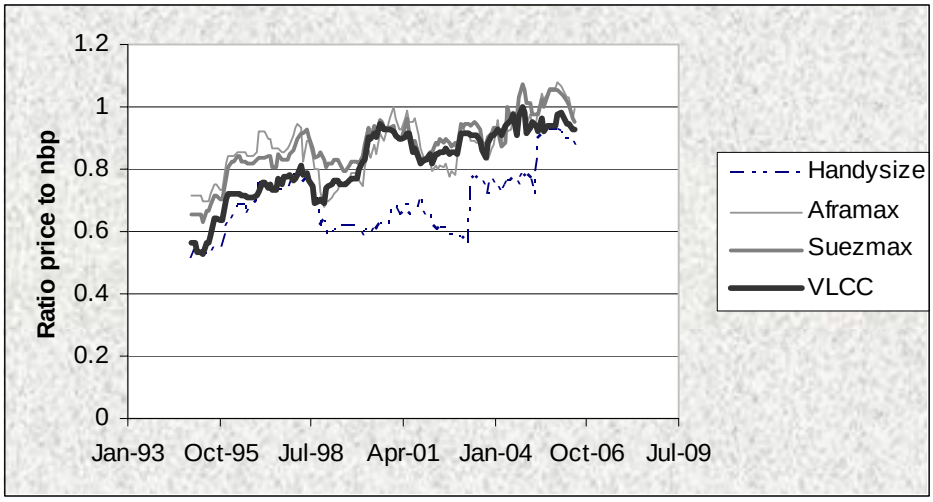
Methodology

For our purposes we used as dependent variable the ratio second hand price according to the vessel size divided by the respective shipbuilding price and a set of variables as the regressors (on the basis of economic theory) in order to create a decision making tool for the ship owner to assist him in the choice “second hand or new vessel”.We apply Maximum Likelihood estimation in the context of a Generalised Autoregressive Conditional Heteroscedastic model GARCH(1,1) with robust standard errors in order to capture the volatility of the ratio as explained by past values of the squared error term and the variance. So the Variance equation is of the following form:

$$\sigma_t^2 = \sigma^2 + \gamma u_{t-1}^2 + \delta \sigma_{t-1}^2 + v_t$$

The ratio's volatility across tanker sizes appears on the following chart:

Chart 1: Ratio Second Hand Tanker price to New building price for each tanker size



We observe that the ratio is subject to a positive trend and increased volatility for crude carriers which can be explained by the variability of second hand prices. For product tankers (handysize) a deviation of time series is observed compared to the other categories.

The conditional mean equation is of the following form:

$$(SHP/NBP)_t = b_0 + b_1\ Tcrate_t + b_2 Volume_t + b_3 CGT_t + b_4 Risk_t + b_4 Crude_t + b_4 Libor_t + \varepsilon_t$$

Where:

SHP: Second hand ship (5 years old) price in millions of US dollars

NBP: Shipbuilding price in millions of US dollars

Tcrate: Average Time charter rate for one year contract (in dollars per day of operation)

Volume: Number of transactions in the Sale and Purchase Market

CGT: Dollars for each compensated gross tonnage (proxy of the shipbuilding cost)

Risk: Volatility of the freight rate, obtained by estimating the AR(2) of the freight rate saving the residuals and constructing their variance

Crude: Price of crude oil in dollars per barrel

Libor: London Inter Bank Offer Rate

Estimation Results

Table 2. Estimation of the decision model with depended variable the ratio second hand ship price over the shipbuilding price using Maximum Likelihood estimation

Segment / Variable	**Aframax**	**Suezmax**	**Vlcc**
TCRATE*	-0.00303(0.00159)	0.01071(0.00117)	0.00195(0.00025)
Volume	0.00133(0.00057)	0.00086(0.00061)	0.00161(0.00042)
CGT*	0.000306(0.00005)	-0.00034(0.00004)	-0.00019(0.00003)
Risk	-	0.00014(0.00003)	0.00016(0.00007)
Crude*	0.00231(0.0005)	-	0.00165(0.00038)
LIBOR*	-	0.01954(0.0079)	-
C	-0.00292(0.00263)	0.01039(0.00317)	-0.00331(0.00159)
σ	-	0.50512(0.16266)	-
Variance equation			
σ^2	0.000376(0.000104)	0.0002(0.00004)	0.00004(0.000008)
ARCH(1)	0.738806(0.325514)	0.63867(0.26571)	-0.12517(0.02293)
GARCH(1)	-0.10734(0.03036)	-0.13412(0.03944)	1.00898(0.01228)
GARCH(2)	0.22254(0.09614)	-	-
Statistics		0.2993	0.25124
R^2	0.0825	343.427	351.147
Log Likelihood	297.146	0.022	0.0206
Standard Error	0.03111	0.0601	0.0539

1 Standard Errors are located in parenthesis. Bollerlsev-Wooldridge robust standard errors and covariance

* denotes that first differences was taken as unit root had been detected for specific variable

First of all we test for the correct model specification. To verify that the mean equation has been correctly specified equation we look at the correlogram of the residuals and observe that the Q-stats are not significant,so we conclude that the mean equation is correctly specified. To verify that the variance equation has been correctly specified we look at the correlogram of the squared residuals, the Q-stats again are not

significant.So we conclude that the variance equation is also correctly specified. Since the variance equation is correctly specified all the ARCH effects should be gone.

For all vessel sizes the ratio is positively related with the freight rate which has to do with the need of ship owners to have a modern second hand vessel delivered as soon as possible in order to exploit the better freight market compared with previous month market. The Ratio drops when the freight rate drops not only due to the reduced price of second hand tankers but also due to the optimism of ship owners regarding the recovery of the market in the future, so they order new vessels, even though after the peek of the year 2004 prices of vessels increased rapidly (for both second hand market and new building). Transactions Volume in the second hand market affects positively the prices in the market, so the ratio increases. Volatility of the freight rates causes increase in the ratio, which implies that owners of crude carriers take over the increased risk involved in this vessel size.

We have tested the significance of the Libor variable for all vessel sizes and it was found significant with positive impact only for Suezmax tankers.This implies that when the cost of financing a vessel is high then owners prefer to invest on this market (for second hand Suezmax) as they prefer to avoid waiting the delivery of the new vessel and therefore suffer higher financial expenses, which also explains the increased second hand Suezmax prices since 2004. The Crude oil variable has positive impact to the ratio as it reflects that increased crude oil price means strong trading of the respective commodity so it implies a strong freight market. The cost to build a ship is perfectly correlated with the price of purchasing a new vessel so a negative relation with the ratio prevails.

The Variance equation will provide us with more evidence regarding the volatility of the ratio. Specifically the ratio is more volatile in the case of sudden news for Vlcc, which is apparent from chart 1. The ratio for this market demonstrates diachronically different behavior compared with other vessel sizes. The sum of the coefficients of the variance equation is close to one for the Vlcc, which is greater than the respective coefficients of the model for Suezmax. This implies that players in the Suezmax market are more rational regarding the news and the changes in the business environment and prices volatility is not that high compared with VLCC. For Aframax the Garch component was also found significant two periods back, and found that the ratio was more volatile and a sudden shock would be quite persistent. For the

Handysize sector we estimate an asymmetric Exponential Garch model and included in the variance equation the Libor variable as can be seen from the table that follows.

HANDYSIZE

Table 3: Estimation of the decision making model with dependent variable the ratio second hand ship price to new building price for **Handysize** tankers

Variable	Coefficient	Standard Error**
Constant	-0.00727	0.00392
Volume	0.00108	0.00035
Tcrate*	0.012008	0.00484
CGT*	-0.00043	0.00007
Risk	-0.00227	0.00065
Variance Equation		
σ	-4.58483	0.76128
$\frac{\lvert u_{t-1} \rvert}{\sigma_{t-1}}$	0.67486	0.21097
u_{t-1}/σ_{t-1}	-1.09175	0.42277
Egarch[1]	0.45603	0.09212
Libor*	-0.95016	0.59046
Stats		
R^2	0.14767	
Log Likelihood	325.697	
Standard Error	0.02909	
S.S.R	0.10499	

**Bollerslev-Wooldridge Robust Standard Errors

*First difference for respective variable

As seen in Table 3, the Volume and the Time charter rate have positive impact to the ratio as expected with statistically significant coefficients. An increase in volatility of freight rate has negative impact to the ratio which implies a more risk averse behavior in that sector. In order to measure the ratio volatility we used Exponential Garch estimation and found lower volatility for that sector following good news as well as lower volatility of the ratio while interest rate increases. This can be explained by the fact that this market becomes more rational while interest expenses increase as more entrance barriers are placed so those who can afford receiving loans with high interest rates can confront a less volatile second hand and shipbuilding market.

SUEZMAX

Table 4: Estimation of the decision making model with dependent variable the ratio second hand ship price to new building price for **Suezmax** tankers

Variable	Coefficient	Standard Error**
Constant	0.01039	0.00317
Volume	0.00086	0.00061
Tcrate*	0.01071	0.00117
CGT*	-0.00034	0.00004
Risk	0.00014	0.00003
Libor*	0.01039	0.0079
σ	0.50512	0.16266
Variance Equation		
σ^2	0.0002	0.00004
u_{t-1}^2	0.63867	0.26571
σ_{t-1}^2	-0.13412	0.03944
Stats		
R^2	0.2993	
Log Likelihood	343.427	
Standard Error	0.022	
S.S.R	0.0601	

*First difference for respective variable

**Bollerslev-Wooldridge Robust Standard Errors

The coefficients on all three terms in the conditional variance equation are highly statistically significant. Nevertheless in this case, the sum of the coefficients on the lagged squared error and lagged conditional variance is not close to one. This implies that shocks to the conditional variance will not be highly persistent. A rather small sum of these coefficients will imply that a large increase or reduction in the price ratio will lead to future forecasts of the variance to be rather low and last for a short period.

Looking at the conditional mean equation, we justify the specification and interpret the results as follows:

Most models in finance assume that investors should be rewarded for taking additional risk by obtaining a higher return. One way to operationalize this concept of risk in the present context is to let the SHP/NBP ratio be partly determined by its variance. So we specified a GARCH-M model where the conditional variance of the

price ratio enters in the conditional mean equation. In the estimated relationship, the conditional variance term that appears in the mean equation has a positive sign and is also strongly significant. This suggests that higher market-wide risk, proxied by the conditional variance, will lead to a higher ratio SHP/NBP.

If the risk associated with the investment decision increases, people prefer to buy a vessel in the second hand market, driving the price up with respect to new building prices. Furthermore, part of the volatility in the tanker sector is attributed or explained by thin trading. So in a volatile market it might be that the denominator of the ratio falls(new orders reduce) which leads to a rise in the ratio SHP/NBP and not necessarily that the numerator rises.

While volatility of the freight rate increases owners prefer to buy Suezmax tankers in order to take advantage of the risky market where maximum return can be achieved, so they acquire second hand vessels in order to avoid the delivery lag of the new built vessels (the positive sign of the risk variable mean that there is positive relationship between risk and the ratio). Despite the fact that thin trading exists in the second hand market for Suezmax there is positive relationship between Trading volume and prices for the second hand deals, so the ratio rises while transactions volume increases.

AFRAMAX

Table 5 Estimation of the decision making model with dependent variable the ratio second hand ship price to new building price for **Aframax** tankers

Variable	Coefficient	Standard Error**
Constant	-0.00292	0.00263
Volume	0.00133	0.00057
Tcrate*	0.003003	0.00159
CGT*	0.000306	0.00005
Crude*	0.00231	0.0005
Variance Equation		
σ^2	0.000376	0.000104
u_{t-1}^2	0.738806	0.325514
σ_{t-1}^2	-0.10734	0.03036
σ_{t-2}^2	0.22254	0.09614

Stats	
R^2	0.0825
Log Likelihood	297.146
Standard Error	0.03111
S.S.R	0.1239

*First difference for respective variable

**Bollerslev-Wooldridge Robust Standard Errors

For Aframax vessels shocks to the conditional variance seem to be highly persistent as the sum of coefficients of lagged squared error and the lagged variance is close to one compared with the Suezmax case. Time charter rate has lower impact than that for Suezmax Tankers to the ratio, which is still positive but smaller which implies that for Aframax, Ship owners are more indifferent in the movement of the freight rates regarding the decision to build a ship or to purchase a second hand vessel. The coefficient of the crude oil variable shows that when the price of the respective commodity increases then they expect a direct recovery of the freight market so they select to expand directly with the acquisition of a second hand vessel, which in our case it is used as a measure of expectations.

VLCC

Table 6 Estimation of the decision making model with dependent variable the ratio second hand ship price to new building price for VLCC

Variable	Coefficient	Standard Error**

TCRATE*	0.00195	0.00025
Volume	0.00161	0.00042
CGT*	-0.00019	0.00003
Risk	0.00016	0.00007
Crude*	0.00165	0.00038
C	-0.00331	0.00159
Variance Equation		
σ^2	0.00004	0.000008
u_{t-1}^2	-0.12517	0.02293
σ_{t-1}^2	1.00898	0.01228
Stats		
R^2	0.25124	
Log Likelihood	351.147	
Standard Error	0.0206	
S.S.R	0.0539	

*First difference for respective variable

**Bollerslev-Wooldridge Robust Standard Errors

As seen in Table 6 the signs of coefficients were found as expected and in the variance equation we can see that persistent shocks do prevail as the sum of coefficients is close to one which is a similar situation with Aframax and more volatile than the Suezmax. In this case it is confirmed that this tanker sector provides to its player the riskiest position as it is required increased amount of capital in order to invest in these types of ships, a fact that verifies the positive relationship between risk and expected return as per portfolio theory. Owners of these vessels are also indifferent regarding the decision to built or buy a ship which it can be seen in the low price of the coefficient of the freight rate even though that marginally they may enter the market through a second hand deal.

Generally when the freight rate increases ratio is driven upwards despite that there is positive relation between freight rate and shipbuilding price, so it works more for the numerator which implies good freight market requires immediate action in order to exploit all the benefits and when freight market is down Ship Owners order new vessels as they are confident for the recovery of the market**.**

Conclusion

We have constructed the functional relationship between the ratio SHP/NBP and its main determinants. This way, the variability and the level of the asset value can be examined with respect to factors that are measurable and that the decision maker should seriously take into account, before acting.

We have also quantified this relationship for the different categories of vessels in the tanker sector and compared and contrasted the results. Estimation of such relationships is of considerable interest to academics and practitioners alike since modeling the behavior of the SHP/NBC has important applications for the initial investment decision of the ship and the forecasting of its future asset value.

Overall, we claim that the cyclicality of the shipping sector together with expectations formed by the agents operating in it (the entrepreneur, the ship-owner and the broker), determine the movement of the ratio and hence the decision of the entrepreneur.

Another important factor which deserves future consideration is the replacement decision of the ship-owner between selling in the second hand market or selling the ship for scrap. Attempts to find data for older ships have been made but are not completed yet.

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