COMPASS MARITIME SERVICES, LLC: SHIP VALUATION

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1. EXECUTIVE SUMMARY

This report offers information about a ship's cost, capacity, and other aspects. The primary goal is to value a ship called the "Bet Performer." We begin with a list of recent capesize ship sales that contains values of ship attributes that can affect the cost of the ship.

We used multiple statistical tools and methodologies like Manhattan distance, Z-Score, and regression to determine the final price of the vessel. According to our evaluation, the recommended price of the Bet Performer should be **137$ M.** We chose market approach to determine the value of the ship.

According to single variable regression model, the best feature to predict the price of ship is age at sale as it returns a good R squared value of almost 65%. Some other factors also affect the ship prices which are oil prices, current location, Current conditions and other market forces like demand & supply. All these factors are explained below in this report.

Using multiple regression, we can comment that all the attributes of the ship (Age at sale, DWT, Capesize) together can explain 92% of the variation in sale price. which is very significant but still can be affected by other factors.

2. MARKET APPROACH

Under the market approach, the price of ship was valued as per the last few comparable ship transactions

Considering all the market factors we can make a prediction that how much the factors can affect the final price of the ship based on current trends.

Closest reference ship which we got by applying the Manhattan distance on all the 48 comparable ships and we got the closest reference ship as Sumihou with the sale price of 106$

3. METHODS & STATISTICAL REASONINGS

3.1 Manhattan Distance

Initially using mean, Standard deviation and correlation we narrowed the search for best fit from 48 to 8 ships by using empirical rule we looked at the mean and standard deviations of all the variable and decided to filter ships that lie in the range of +1 to -1 standard deviation(our results filtered the ship with the following criterion : DWT : 155-189, Sale Price : 39 to 105 Million, Age : 8 to 20 Years, Capesize : 5144 to 10143), then out of these 8 ships we shortlisted 3 ships which were closest to the Bet Performer in reference to age, year built, sale price and DWT. We then used Manhattan distance a method to find the closes ship to the Bet Performer. Furthermore, we used regression analysis and to find the estimated price of the bet performer with respect to all other factors such as DWT, Capesize and Age at sale.

Combining the results of Manhattan distance, Regression analysis, bell curve analysis and then looking at the current market trends we found valuable insights leading us towards a final price of the Bet Performer.

Initially we standardized the data by finding Z values by subtracting mean and dividing the results by the standard deviation of all two factors (Age at sale, DWT). We did not take into account the capsize values in the Manhattan since the capsize is changing with month and it would not indicate us the closest ship to the Bet Performer. While we got 48 different Manhattan distances, the lowest distance shows the highest closeness with Bet Performer. According to the results, the closest ship comes out to be the Sumihou with the lowest Manhattan distance of 0.05. (Exhibit 1)

Exhibit 1

Sale Date	Vessel Name	Sale Price ($US millions)	Year Built	Age at sale (Years)	Dead-weight Tons	Baltic Dry Capesize Index	Total Manhattan distance
Nov-07	Sumihou	$106.0	1996	11	171.1	9,663	0.05
May-07	Ingenious	$64.2	1996	11	170.0	6,201	0.11
May-07	Zorbas II	$86.0	1996	11	174.5	6,201	0.14
May-07	Fertilia	$50.5	1997	10	172.6	6,201	0.19
Mar-08	Cape Sun	$135.0	1999	9	171.7	11,193	0.33
Mar-07	Zorbas	$70.0	1996	11	165.1	5,245	0.39
Jan-07	Lowlands Beilun	$73.0	1999	8	170.2	4,647	0.58
Feb-07	Pantelis SP	$83.0	1999	8	169.9	4,878	0.59

3.2 Regression Analysis

3.2.1 Singe Variable Regression Analysis

As part of our next steps, we calculated the linear regression equation and analysed the data through scattered plot and various other values such as R square & P value. Regression analysis explains how independent variables affect the dependent variable in the form simple linear equation, which helps us to predict approximate value of dependent variable with respect to independent variable. We calculated the estimated price of Bet Performer using regression with reference to sale price and age at sale, Sale Price and DWT and Sale price and capsize.

In our model, we have 3 important factors affecting the sale price of the ship.

1. Age of sale
2. DWT
3. Capesize Index

Age of sale: After using regression analysis between sale price & Age of sale, for bet performer whose age is at the time of sale is 11 years (X_1),

$$Y = \alpha + (\beta_1 * X_1) + (\varepsilon_1)$$

$$\beta_1 = -4.22,\ \alpha = 133.13,\ \varepsilon_1 = 7.58$$

We get sale price = 86.75 + 7.58 = $94.33M

Adjusted R^2 value= 61.5%, this means 61.5% of the variance in sale price can be explained by age (Exhibit 5)

DWT (kilo tons): After using regression analysis between Sale price & DWT, given that the DWT for bet performer DWT is 172 kilo tons (X_2),

$$Y = \alpha + (\beta_2 * X_2) + (\varepsilon_2)$$

$$\beta_2 = 0.98,\ \alpha = -84.16,\ \varepsilon_2 = 38.81$$

We get sale price = 84.39 + 38.81 = $123.2M

Adjusted R^2 value= 24.9%, this indicates that 24.9% of the variation in sale price can be explained by DWT (Exhibit 5)

Capesize Index: After using regression analysis between Sale price & DWT, given that the capesize index for the Bet performer in May 2008 is 12479 (X_3),

$$Y = \alpha + (\beta_3 * X_3) + (\varepsilon_3)$$

$$\beta_3 = 0.0048,\ \alpha = 36.43,\ \varepsilon_3 = 15.03$$

We get sale price = 96.33 + 15.03 = $111.36M

Adjusted R^2 value= 10.5%, which indicates that 10.5% of the variation in sale price can be explained by Capesize Index (Exhibit 5)

Single Variable regression analysis indicates us how independent variable is affecting the variance of dependent variable. But while calculating single variable regression analysis, we consider that the other factors have no significance or that they are constant, which is not always true. For example, while calculating sale price from age of sale regression model, we are not considering the effect of DWT and Capesize index on age of sale. There is a chance that all independent variables are correlated to each other too. So single variable regression is not necessarily a good model if there are more than 2 factors affecting our dependent variable. (Exhibit 2,3,4 and 5)

Exhibit 2

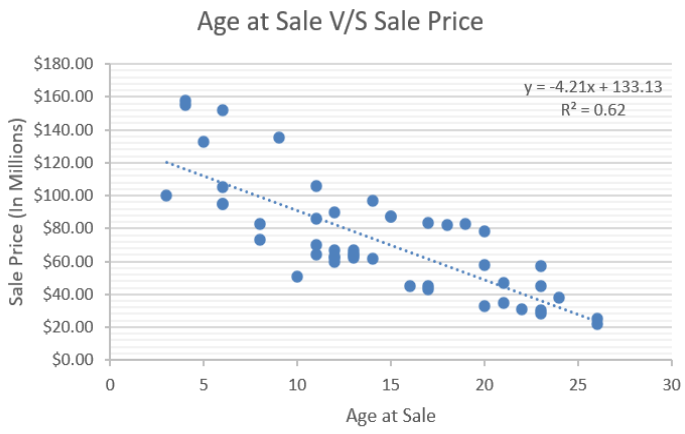


Exhibit 3

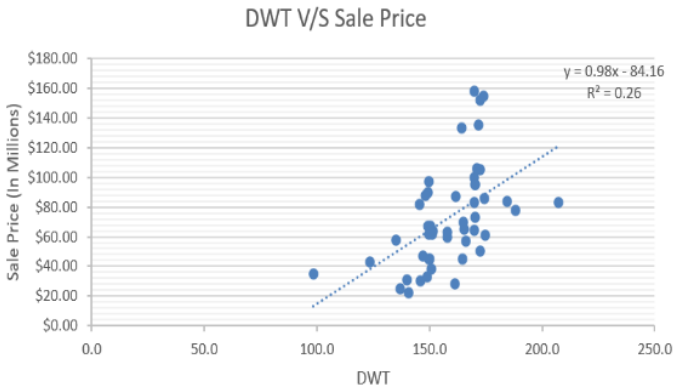


Exhibit 4

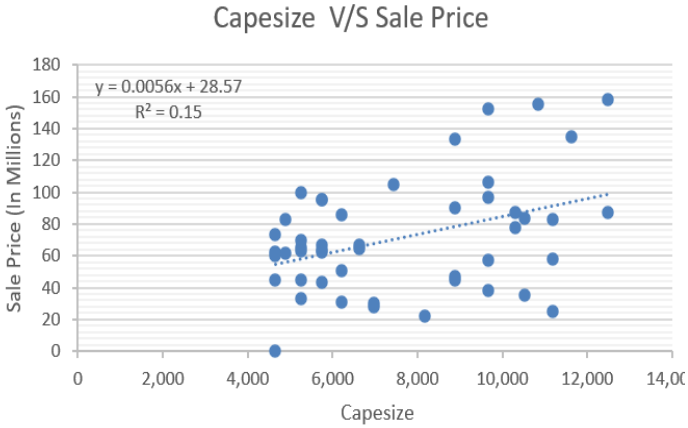


Exhibit 5

Single Variable Analysis Against Sale Price (y)	Age of sale (x1)	DWT (x2)	Capesize (x3)
Intercept	133.12	-84.16	36.43
Correlation	-0.78	0.51	0.35
Standard Error	7.58	38.81	15.03
Coefficient	-4.21	0.98	0.0048
R-Square	0.62	0.26	0.12
Adjusted R-Square	0.61	0.24	0.10
Sale Price (without error)	86.74	85.87	96.33

3.2.2 Multivariable Regression Analysis

Since all 3 factors have significant influence in sale price, single variable regression model cannot indicate a good prediction value. Hence, we ran multiple regression model to get a better prediction value for sale price of ship where all 3 independent variables are considered. Using multiple independent variables to influence our dependent variable, the sale price, allowed us to create a model that is more accurate. Due to the inclusion of all influencing factors, this prediction model outperforms single variable analysis.

The multiple regression analysis reduces the variance of sale price by 91.5% with an R^2 value of 0.915. This is significantly better than single variable regression since the greatest R^2 value in single variable analysis was 62%, which is considerably less than the R^2 value in multivariable analysis.

From Exhibit 6, we have the coefficients (β) of each independent variable and also the intercept (α) from multi regression analysis. We can use these values to approximate the sale price of the ship and add a buffer of standard error value (**ε**).

$$Y = \alpha + (\beta_1 * X_1) + (\beta_2 * X_2) + (\beta_3 * X_3) + (\varepsilon)$$

X_1 = Age of sale of bet performer = 11 years
X_2 = DWT of bet performer = 172 Kilo tons
X_3 = Capesize index in May 2008 = 12,479
From Exhibit 6, α = 44.22
β_1 = -4.54
β_2 = 0.24
β_3 = 0.0072
Sale price from multi variable regression analysis Y = 125.75
Finally, including our standard error (**ε**) Y = 125.75 +/- 9.88 = **$135.63M/ $115.87M**
Adjusted R^2 value= 91.5%, which indicates that 91.5% of the variation in sale price can be explained by Capesize Index (Exhibit 6)

Exhibit 6

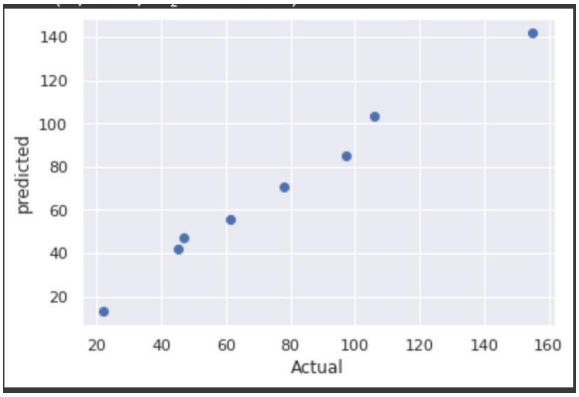
Multivariable regression analysis	Regression model values
Intercept	**44.22**
Standard Error	**9.88**
Age of sale Coefficient	**-4.54**
DWT Coefficient	**0.24**
Capesize Coefficient	**0.0072**
Adjusted R-Square	**0.915**
Multiple R	**0.95**
Sale price	**125.43**

Using the above data, we can comment that if the

ship was 5 years younger, it would've been sold for $148.55 Million, if the ship were 20K lighter in DWT, it would've been sold for $120.98 Million, if the charter rate were 30% lower, the ship would've been sold for $98.84 Million, If all these conditions are met jointly the price would be $116.67 Million.

Going forward, we tried to verify our results with machine learning model. We created a machine learning model for linear regression to predict the price of ship. To achieve this, we split the dataset for training and testing. We took 15 percent of total data for testing, while the rest 85% of the data was used for training purposes. We then deployed linear regression model and fitted our train data to model for training. After training with (DWT, Capesize, age at sale) we passed our test data (DWT, Capesize, age at sale) into model for prediction (Price). The Model generated prediction for the test data and we achieved similarity between test price and predicted price by **96 percent** accuracy and a MSE (mean squared error) of 8. Given this accuracy, we predicted the value of ship, so we passed our ship data to ML model for predicting price. The model returned $123.49M. (Exhibit 7)

Exhibit 7



4 EXTERNAL FACTORS

These are those factors which affected the price of ships. Factors includes:

- Oil prices affect the current market rates of BACI. We know that capsize index increases if the prices of iron ore and coal increases and iron ore and coals prices are directly proportional with the oil prices. We also know that the oil prices were soaring at that time and in May 2008, it was near to the all-time high value of 145$.
- Loan rates were very low. Loans were easily available and on easy credit. We do not have any idea on what these rates will be in the future
- The economic conditions were very volatile and sellers dominated the deals, we know that if we made an offer below the market rate, the deal will be at risk.
- The average price of sold ships from March to May for ships with more than 160 DWT is $126.73M.
- The market was really booming as the demand was very high.
- The current location of the ship would also play a major role in determining the final price.
- The present condition and maintenance status of the ship can also affect the price of the ship.

5 PRICE DETERMINATION FOR BET PERFORMER

By Combining all the results of regression analysis and the external market factors we recommend the estimated price of the Bet Performer to be **$137** million.

The price by multiple linear regression is $125.75 Million and the standard error is 9.88.

By adding standard error in the regression price, we get the final price.

6 LIMITATIONS

There are many factors which can affect the price of the ship, but we don't have that information, so we took the final decision without these parameters listed below:

- We don't know the current location of ship when it will be sold.
- Condition of the ship is not known.
- Any other factor which is related to the quality and physical characteristic of the ship.
- Port charges across the world can be different and hence can play a role in determining the ship's price.

7 CONCLUSION

From all the above calculation and analysis, we believe the estimated price of the Bet Performer should be $135.63 million, however we'd also suggest the client to keep in mind the external market factors discussed in the summary as they may play a pivotal role in deciding the ship's price

8 References

Comapss Maritime Services , LLC Valuing Ship HBR

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