Spot market employment more profitable

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1 Introduction

Whether to employ a ship on spot or on a period time charter (TC) is not an easy decision to make. If one believes that the market is about to have an upturn one would naturally consider the spot market. However in an efficient market an upward sloping market should be reflected in the time charter rate. The same should hold for a downward sloping market. However if one believes that the future market is not reflected in price of the time charter one might be able to get away with a bargain. By placing a ship on a long time charter the owner is neutral in the market and have effectively isolated the asset play. By placing the ship in a pool the owner increases her or his risk under the assumption of greater future return. However as the time charters are over the counter products there is especially for long time charters a counterparty risk present.

In this article we wish to analyse whether one historically would be better of employing a panamax on a rolling 11-13 months time charter than in the spot market. In order to avoid timing effects we draw random date ranges for which we calculate the average earnings for rolling time charter and spot contracts. We also consider the effects of the option period incorporated in the time charter. In this study the P4TC index is used as the price for the spot contract.

2 Methodology

2.1 Simulations

In order to investigate whether one would be indifferent in employing ships in the spot or time charter market a simulation study is conducted. We assume that we have one ship that we can either place on a rolling spot or in the time charter market.

1. Spot: A panamax is continuously employed in the spot market lasting 45 days and is tied to a fixed panamax index (P4TC).

2. Time charter: The ship is placed on a 1 year time charter with a 2 months option period (11-13 month). After 10.5 months the receiver of the ship decides whether she or he will return the ship to the owner. The ship will be returned 15 days after the notice is sent. The option can be exercise at any time in the option period. The assumption is that the receiver of the ship will only send a notice if the current time charter rate is lower than the agreed time charter rate in the contract. When the ship is returned to its owner we assume that the owner immediately employs the ship in the time charter market.

We randomly draw subintervals from the period 2001 to 2017. For each randomly selected interval we calculate the average daily earnings for the spot and time charter strategy. This exercise is repeated 100,000 times. This leaves us with 100,000 subintervals with one average spot and time charter earning per vessel per day. In total we get 100,000 data points for the spot strategy and 100,000 for the TC strategy.

The number of simulations for each (investment horizon, start year) is given in table 1.

IH	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	118	220	242	276	262	272	345	319	402	510	536	702	837	1167	1973	6339
2	337	470	498	520	577	585	682	719	803	951	1176	1375	1805	2626	4429	
3	316	415	468	482	544	633	683	771	864	946	1120	1438	1854	2561		
4	307	458	450	558	533	630	661	778	794	1000	1179	1400	1811			
5	343	445	483	523	552	616	677	787	836	996	1166	1384				
6	330	439	449	512	522	610	663	743	859	1030	1196					
7	291	404	491	471	541	625	652	746	817	930						
8	284	464	468	486	513	578	676	804	837							
9	327	432	454	561	563	616	705	759								
10	330	412	433	539	543	602	653									
11	282	425	469	490	514	619										
12	314	439	455	483	636											
13	317	393	465	539												
14	303	415	477													
15	322	428														
16	320															

Table 1: Matrix M: distribution of simulations for each pair of (investment horizon, start year). The distribution is clearly skewed to the south east in the table. This affects the weighting when calculating average earnings over investment horizons and start years. The abbreviation IH stands for Investment Horizon

As observed in matrix M in table 1 the distribution of simulations is very skewed. As the main objective in the article is to compare time charter versus spot employment over the length of the sub-intervals it would be ideally if $M_{(i,j)} = K_i$ for all investment horizons i and years j. This is solved by sampling with replacement so that $\sup_j M_{(i,j)} = M^*_{(i,j)}$. This procedure results in a new distribution of simulations as showed in table 2.

When calculating the mean over each (investment horizon,year) we assume that $\hat{\mu}_{(i,j)} \overset{n->\infty}{\rightarrow} \mu_{(i,j)}$. The same goes for the variance. However the total number of samples for each investment horizon will be different. Thus when calculation the mean over all years and investment horizons we calculate the weighted (1) mean and non-weighted mean (3).

IH	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	6339	6339	6339	6339	6339	6339	6339	6339	6339	6339	6339	6339	6339	6339	6339	6339
2	4429	4429	4429	4429	4429	4429	4429	4429	4429	4429	4429	4429	4429	4429	4429	
3	2561	2561	2561	2561	2561	2561	2561	2561	2561	2561	2561	2561	2561	2561		
4	1811	1811	1811	1811	1811	1811	1811	1811	1811	1811	1811	1811	1811			
5	1384	1384	1384	1384	1384	1384	1384	1384	1384	1384	1384	1384				
6	1196	1196	1196	1196	1196	1196	1196	1196	1196	1196	1196					
7	930	930	930	930	930	930	930	930	930	930						
8	837	837	837	837	837	837	837	837	837							
9	759	759	759	759	759	759	759	759								
10	653	653	653	653	653	653	653									
11	619	619	619	619	619	619										
12	636	636	636	636	636											
13	539	539	539	539												
14	477	477	477													
15	428	428														
16	320															

Table 2: Matrix M^* Distribution of simulations for each pair of (investment horizon , year) after sampling with replacement. Now the number of samples for each (i,j) over $j \in [2001, \cdots, 2016]$ is equal. IH: Investment Horizon.

$$\mu_w = \frac{1}{K} \sum_{i=1}^{16} K_i \hat{\mu_i} \tag{1}$$

$$= \frac{1}{K} \sum_{i=1}^{16} K_i \Big(\frac{1}{Y_i} \sum_{j=1}^{Y_i} \hat{\mu_{i,j}} \Big) \tag{2}$$

$$\mu_{uw} = \frac{1}{16} \sum_{i=1}^{16} \hat{\mu_i} \tag{3}$$

where $K = \sum_{i=1}^{16} K_i = \sum_{i=1}^{16} \left(\sum_{j=1}^{Y_i} M^*_{i,j} \right) = \sum_{i=1}^{16} Y_i M^*_{i,1}$. The integer Y_i is the number of years considered for investment horizon i, for instance $Y_1 = 16$ while $Y_{16} = 1$. While K_i is the total number of simulations per investment horizon.

2.2 Hypothesis testing

In order to assess whether the spot and time charter earnings differs significantly we run a series of hypothesis tests based on the underlying data. The goal is to reveal differences in the two strategies.

2.2.1 Normality of data

Most hypothesis tests in this study assumes normality in the data. We therefore test the hypothesis of normality in the data using the Jarque Bera test of normality.

2.2.2 Equal mean

Naturally we wish to test whether the average earning for the time charter strategy is statistically different to the spot strategy. In other words we wish to test

$$\mathrm{H}_0 : \mu_{\mathrm{spot}} = \mu_{\mathrm{TC}} \tag{4}$$
$$\text{vs. } \mathrm{H}_1 : \mu_{\mathrm{spot}} \neq \mu_{\mathrm{TC}} \tag{5}$$

Depending on the distributional properties of the spot and time charter average earnings this can be done using one of the following tests

- Two sample t test (Welch's test): Under this test it is assumed that the data are independent random samples from a normal distributions with means μ_{spot} and μ_{TC} and with standard deviations σ_{spot} and σ_{TC}
- Paired t test: Same assumptions as in the two sample t test but now we assume that the standard deviation in both samples are equal.
- Wilcoxon Signed Rank test: A nonparametric test on paired data for testing whether the averages of two samples are equal.
- Wilcoxon Rank sum test: A nonparametric test on non-paired data assumed to come from the same distribution with a possible shift in location for whether the averages of both samples are equal.

The first two tests assumes that the data comes from a normal distribution. While the Wilcoxon rank sum test is the nonparametric counterpart of the paired t test. Hence, if we reject the hypothesis of normality (section 2.2.1) then our last resort is the Wilcoxon tests. In order to select the right Wilcoxon test we need to decide on whether the data is paired or not. A definition of paired data from wikipedia explains paired data as "Scientific experiments often consist of comparing two or more sets of data. This data is described as unpaired or independent when the sets of data arise from separate individuals or paired when it arises from the same individual at different points in time."[1]. Hence the question becomes whether the time charter or spot earnings originates from the same data i.e. if both strategies can be seen as a treatment of the same underlying asset.

2.2.3 Equal Variance

We can test whether the spot and time charter earnings has the same variance in earnings. This is done using the Bartlett's test.

2.2.4 Equal distributions

Another important factor is whether the distribution of the average spot and time charter rates are similar. One part of testing this is by testing if the mean, median, variance and higher moments are different. The hypothesis test regarding means was discussed in 2.2.2.

Using the Kolmogorov-Smirnov test (KS-test) one can test whether the time charter earnings and the spot earnings belongs to the same distribution. If this is the case then we could conclude that there is no significant difference between spot and time charter earnings and hence one would be indifferent in employing a panamax in the time charter or spot market.

3 Data Quality

Now in order to conduct the analysis laid out in 2.1 we need daily spot and time charter prices. The spot strategy uses the P4TC index price provided by the Baltic Exchange which is of daily resolution. Clarksons publish time charter rates for various ship sizes. We have selected to use the weekly 75,000 dwt time charter rates in this analysis. The weekly time charter rates is converted to daily by filling the daily fields with the last recorded price.

4 Simulation Results

To compare the P4TC spot earnings with the time charter earnings we start by studying their descriptive statistics. The average earnings for each investment horizon is given in table 3. It can be observed that the spot strategy as laid out in section 2.1 outperforms the alternative for investment horizons of 1 to 2 years and 11 to 16 years. Overall the weighted and un-weighted means are both in the favor of the spot strategy. It can also be noted that the spot strategy clearly outperformed the time charter over the full 16 year time horizon. However for horizons lasting 3 to 10 years the time charter strategy proved to be the top performer.

IH	TC	SPOT	TC-SPOT
1	19943.7	20038.3	-94.5914
2	20759.3	20793.8	-34.4896
3	21819.6	21791.9	27.6904
4	22502.6	22478.8	23.8755
5	23120.9	22948.3	172.547
6	23746.1	23645.9	100.262
7	24396.3	24253	143.298
8	24687.9	24345.3	342.63
9	24700.6	24337.8	362.837
10	24415.8	24246	169.806
11	23602.3	23674.1	-71.848
12	22855.7	22992.3	-136.661
13	22273.8	22489	-215.239
14	21479.4	21797.5	-318.036
15	20533.9	20896.9	-363.001
16	19601.4	20083.8	-482.407
μ_{uw}	22527.5	22550.8	-23.3328
μ_w	21434.2	21438.7	-4.51856

Table 3: Empirical means over various investment horizons and for the dataset overall.

Another important statistics when comparing performance of strategies is the standard deviation of the earnings for each subinterval. This statistic is reported in table 4. In general the spot strategy has a greater variation in earnings than for the time charter strategy. This should not come as a surprise but rather as a supplement to the findings in table 3. It is clear that the average earnings is not necessarily the determinant of a strategy's success but rather how it compares to the variation in earnings. It is interesting to note how the spot strategy outperforms the alternative and with a lower variation over the 16 year investment horizon.

	TC	SPOT	TC-SPOT
1	14387.465872	15063.001121	9511.687221
2	13507.444513	13817.206307	6923.414075
3	11841.146142	12368.929924	5211.985560
4	10640.492573	11556.854868	4543.479767
5	9679.557532	10817.597945	4212.720701
6	8545.995771	9799.941700	3905.124373
7	7022.212996	8509.342043	3495.515801
8	5654.265251	7011.543788	2863.474082
9	3737.868039	5374.863333	2679.570860
10	2358.145980	3453.781986	2047.532511
11	1884.298011	2475.771974	1592.838807
12	1463.269302	1853.770252	1299.589732
13	846.793934	1042.875799	1113.784140
14	711.885351	492.382666	760.426009
15	608.378611	375.356064	622.176560
16	545.126530	247.579093	533.238327
σ_{uw}	7574.663765	8257.217831	4013.397506
σ_w	12210.845291	12842.289658	7014.756650

Table 4: Standard deviations in earnings for the spot and time charter strategy over all investment horizons.

It is also of interest to study the skewness and excess kurtosis of the spot and time charter strategy. The skewness reported in table 5 illustrates that the distribution is clearly not symmetric for either spot nor time charter earnings. The same can be said about the excess kurtosis in table 6. It is interesting to observe how the excess kurtosis generally decreases as the investment horizon increases. This is clearly a result of the timing effects.

	TC	SPOT	TC-SPOT
1	1.48339	1.31932	0.768583
2	1.29932	0.849133	0.136547
3	0.74377	0.364821	0.127001
4	0.368121	0.0923585	-0.117743
5	0.0512979	-0.103272	-0.404304
6	-0.253666	-0.360747	-0.316403
7	-0.653678	-0.636768	-0.0884057
8	-1.02143	-0.785733	0.402266
9	-1.15498	-0.941868	0.454765
10	-0.45387	-0.539501	0.405474
11	-0.625253	-0.402269	0.430961
12	-0.841378	-0.616349	0.388039
13	-0.0898548	-0.581071	0.329201
14	0.492715	0.467324	0.277386
15	0.401728	0.0766496	0.514925
16	0.650999	0.0195557	0.567426

Table 5: Skewness over the different investment horizons.

The skewness and excess kurtosis reported in table 5 and 6 points to a preliminary hypothesis of the distribution of time charter earnings, spot earnings and the difference being non-normal. This hypothesis can be tested using the jarque bera test statistic discussed in section 2.2.2. The p-values from the jarque bera test is reported in table 7. It should come as no surprise considering earlier analysis that the hypothesis of normality is rejected most of the times. The only case when it is not rejected is for the spot strategy over the 16 year investment horizon. This is probably due to the averaging effects this strategy has over the whole simulation period.

As the hypothesis of normality in earnings is rejected in most of the cases it should not be advisable to assume normality in the earnings. This leads to use of non parametric hypothesis tests when comparing the time charter and spot strategy over the investment horizons.

	TC	SPOT	TC-SPOT
1	1.68142	1.35657	4.1244
2	1.22004	-0.171786	2.39824
3	-0.452868	-1.11175	0.97638
4	-1.14661	-1.43083	0.363078
5	-1.38458	-1.49715	0.519857
6	-1.35139	-1.40585	0.0529612
7	-0.906183	-1.14664	-0.127252
8	0.0312062	-0.781851	-0.271745
9	1.29016	-0.0958573	-0.410663
10	-0.454028	-0.891262	-0.320227
11	-0.0114229	-1.38298	-0.360572
12	1.02454	-0.98659	-0.425277
13	0.69441	-0.693081	-0.264458
14	0.2151	-0.408148	-0.273844
15	0.31696	-0.492919	0.12487
16	0.701472	-0.594036	0.902606

Table 6: Excess Kurtosis over different investment horizons.

	TC	SPOT	TC-SPOT
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0
7	0	0	9.89369e-05
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
12	0	0	0
13	1.21074e-10	0	1.47521e-10
14	7.61613e-14	3.36398e-14	1.07033e-05
15	1.91697e-06	0.00803909	5.10868e-09
16	6.77506e-07	0.0873289	1.30405e-06

Table 7: Jarque Bera P-values for the hypothesis test of normality in earnings over different investment horizons.

	Ranksum	Wilcoxon	Kolmogorov-Smirnov	Bartlett
1	2.74489e-76	1.63582e-47	0	2.42185e-48
2	1.22762e-47	7.96888e-56	0	5.10173e-09
3	6.58924e-17	2.87497e-06	0	1.51117e-16
4	0.000810851	4.28696e-09	2.8589e-256	8.87768e-37
5	0.0601612	3.36138e-35	2.5565e-148	1.90035e-46
6	0.0470303	3.44674e-12	7.04688e-66	2.11828e-55
7	8.01076e-09	4.75005e-05	1.70417e-69	3.86734e-76
8	3.15085e-06	7.86021e-11	7.19306e-72	3.2044e-77
9	1.77949e-09	9.54118e-10	4.68029e-108	1.75142e-172
10	1.08189e-06	0.00464146	3.14609e-98	2.42539e-143
11	9.94275e-15	1.1744e-06	3.18425e-105	2.15245e-61
12	2.44262e-22	7.12359e-13	5.85436e-83	3.24338e-40
13	1.57654e-26	2.92296e-21	3.49364e-52	5.79905e-22
14	1.0263e-46	2.68765e-48	3.43306e-49	3.12122e-43
15	1.52273e-51	8.42991e-49	8.95164e-50	1.17204e-43
16	9.73603e-42	3.07156e-33	7.97795e-48	3.40894e-41

Table 8: P-values for tests of equal moments and distributions for the historical spot and time charter earnings.

The hypothesis tests described in 2.2.2 and 2.2.3 are reported in table 8. The ranksum test of equal means was not rejected on a 1% significance level for investment horizons of 5 and 6 years. The empirical difference over these two horizons was, as given in table 3, \$172 and \$100 per day. For the remaining horizons the hypothesis of equal means are rejected in favor of the alternative. The Wilcoxon signed rank test rejects the null of equal means for all investment horizons. Hence it can be concluded that the difference between time charter and spot earnings are statistically significant different from zero.

The Kolmogorov-Smirnov test of equal distributions is also rejected for all investment horizons. Thus it is reasonable to conclude that the earnings have very different distributional properties. This also reinforce the empirical results found in table 3 through 6.

The Bartlett's test of equal variance supports the empirical results in table 4 that the variance for the spot earnings is generally greater than for the time charter.

Finally, in order to investigate whether it is possible to predict the ratio between the time charter and the spot strategy the regression in (6) is ran. We only consider investment horizons of lengths less than 2 years as we only use panamax front months, M_j for $j \in (1, \ldots, 20)$, extending 20 month forward. The factor TC_i and $P4TC_i$ is the current time charter rate and panamax index at the start of the simulation i.

$$\Big(\frac{\text{time charter}}{\text{spot}}\Big)_i = \alpha_0 + \alpha_1 IH_i + \sum_{j=0}^{20} \beta_j M_{j,i} + \sum_{k=0}^{20} \rho_k \frac{M_{k,i}}{TC_i} + \sum_{m=0}^{20} \gamma_m \frac{M_{m,i}}{P4TC_i} + \epsilon \tag{6}$$

The regression results returns an R^2 adjusted of 65%. The skewness and kurtosis in the residuals are -0.2 and 4.8 respectively and this leads to the jarque bera hypothesis of normality being rejected. It is therefore clear that there is still something unexplained in the data. One explanation might be that the front months represents expectations of the future and not the actual future. By only considering an investment horizon of 1 year the R^2 adjusted becomes 78.6%.

5 Conclusion

In the analysis of spot versus time charter earnings we have discovered that:

- A rolling P4TC spot strategy outperformed a rolling 12 months time charter for investment horizons lasting one to two and 11 to 16 years. While the time charter strategy was the top performer for periods lasting three to 10 years.
- The difference in average earnings between the two strategies was \$23 and \$4.5 in favor of the rolling spot strategy for the un-weighted and weighted mean respectively.
- For short to medium sized horizon the spot strategy had a greater variation in earnings than for the time charter. This was also tested and confirmed by the Bartlett's test for equal variance.

It should be noted that the historic performances is not necessarily a predictor of the future.

References

[1] *Paired data.* URL: https://en.wikipedia.org/wiki/Paired_data.