The Review of Finance and Banking
Volume 05, Issue 2, Year 2013, Pages 117–128
S print ISSN 2067-2713, online ISSN 2067-3825

PORTFOLIO DIVERSIFICATION BENEFITS IN SHIPPING INDUSTRY: A COINTEGRATION APPROACH

SINEM DERINDERE KÖSEOĞLU AND ALI ÖZGÜR KARAGÜLLE

Abstract. This study examines the possibility of risk reduction benefits for bulk shipping sector from diversification between 2002 and 2011 by using weekly data. Multivariate cointegration as well as correlation analysis is used in order to investigate whether there are benefits from different vessel diversification. One year time charter rates of ten different ship types, both tankers and dry bulkers, are obtained for this purpose. Both cointegration and correlation analysis show that risk reduction benefits can be achieved from diversified fleet in some cases. According to the cointegration analysis, we cannot reject the null hypothesis of no cointegration in most bivariate vessel combinations, however not both of them should be bulk carriers, thus constructing vessel portfolio, which includes only dry bulkers, does not lead to any risk reduction benefits. This means that in case of bulk carriers series the Johansen test revealed zero cointegrating vectors. Furthermore, diversification benefits are existent in the combination of at most four different vessels, no possibility of risk reduction from portfolios consisting of more than four vessels.

1. INTRODUCTION

Investing in real assets or securities always incurs risks due to the uncertainty of the future. However, the values of these investments do not move up and down in perfect synchrony in general. In other words, they do not perform the same way under the same market conditions because of the specific risks. Therefore, diversification can eliminate such specific risks. Diversification can be used as a competition tool in order to gain sustainability, one of the main pillars of strategic management. This tool can be used as a part of an offensive strategy for growth or can be used as a defensive strategy to reduce risk in product and market decisions. In finance, diversification is a technique to reduce investments risk by investing in a variety of assets. It can be summed up with this proverb "Don't put all of your eggs in one basket". Portfolio theory was first introduced by Harry Markowitz in 1952 with his paper Portfolio Selection. In his pioneer work, Markowitz developed an analytical diversification strategy by considering correlations of assets rather than simple diversification. According to Markowitz, diversification with perfect positive correlation does not reduce risk in the portfolio; therefore investors must combine assets with zero or negative correlations to reduce investment risks. In more detail, they should focus on risk and return characteristics in selecting portfolios such a way that will result in minimum risk at a given level of return, which are also called efficient portfolios.

The business of shipping has also been characterized as highly risky (Skjetne, 2005), and therefore the investors in the shipping industry, especially in the tramp shipping sector, require higher expected return from highly risky investments. Thus, building an efficient vessel portfolio

Received by the editors February 13, 2013. Accepted by the editors December 7, 2013.
Keywords: Cointegration, Portfolio Diversification, Tramp Shipping Markets.
JEL Classification: G11, L91.
Sinem Derindere Köseoğlu, PhD, is Assistant Professor of Finance at the School of Transportation and Logistics Istanbul University. Email: sderin@istanbul.edu.tr.
Ali Özgür Karagülle, PhD, is Assistant Professor at the School of Transportation and Logistics, Istanbul University. Email: ozgurk@istanbul.edu.tr.
This paper is in final form and no version of it will be submitted for publication elsewhere.

is a crucial issue for the industry and this depends on revealing the possibility of diversification benefits in the industry. In other words the aim of the paper is not building portfolio, it is only the verification of the possibility of its building. As the shipping is a highly segmented industry, ship owners or shipping firms might benefit from diversification as a technique to reduce risks. In real world, it can be seen that some shipping companies operate a diversified fleet while others focus on only one segment, one vessel size. Flexibility of the fleet and interchangeability of vessels can be determinant on an efficient fleet management. So, fleet decisions are directly related with functional goals (especially marketing) and also with strategic decisions. An obvious question here is the tramp shipping industry can really benefit from diversification?

One way of testing if risk reduction is possible from diversification is a correlation analysis. According to Markowitz Diversification Theory, investors combine assets with zero or negative correlations to reduce investment risks. Therefore in our analysis, we first conduct correlation analysis to see if investors can be benefit from diversification in shipping industry. However, correlation tests in general do not give information about long run dynamics between variables. The long run dynamics are indeed very important due to the common feature of long term investments in the industry. Cointegration analysis allows us to investigate the existence of long run relations between the freight rates of different vessels. The existence of long run relationships between freight rates is very important knowledge for building an efficient vessel portfolio. Because the existence of the relationship between vessels implies that in the long run revenues of these vessels move together and therefore, the benefits from diversification with the building of a portfolio that combines them are limited. Thus, we second conduct multivariate cointegration analysis to analyze if there exists a long run relationship between freight rates of different vessels in tramp shipping sector. In summary, it is the purpose of this research to conduct the correlation and cointegration analysis for different vessel freight rates to reveal the potential of risk reduction benefits for a bulk shipping investor through diversification. In other words, it has been tried to show the freight rates are or are not cointegrated.

The rest of the paper is organized as follows. Section 2 is literature review. Section 3 is about the methodological design of the study. Section 4 presents a brief description of the data and some summary statistics. Finally, Section 5 summarizes the study and concludes with some general observations.

2. LITERATURE SURVEY

Sustainability and long term existence are one of the main purposes of strategic management. Corporate and business level strategies are dimensions of decisions that lead to sustainability and competitive advantage when used in coordination with each other. As Hitt, Ireland and Hoskisson (1999) point out diversification as a tool to overcome rivals, it can be used as a tool to reduce risks or having options to choose in high uncertainty about market, products and services. Economists indicate that investors can benefit from diversification when they hold a portfolio consisting of many assets. Since then many researchers investigate the relationships between assets to reduce their risks. There are lots of such studies especially in stock markets. These studies at first investigate the correlations among stocks markets and stocks. (Adjaoute and Danthine (2001), Kempa and Nelles (2001)). However, because of some drawbacks of using correlations to determine investment strategy, a number of studies then employ cointegration approach to examine whether linkages and long term relations among these stocks and stock markets show possibilities to reduce risk by diversification (Kanas (1998), Girard and Ferreira (2004), Kazi (2008), Majid et al. (2009)). These kinds of studies have also been done for other markets such as real estate markets (Wilson et al. 2002, Liow and Yang 2005,Galla et al., 2013) and hedge funds (Gregoriou and Rouah2001, Füs and Kaiser, 2009) as well as stock markets.

As discussed in the above literature, although there are many studies which analyze the possibilities to benefit from diversification by using correlation and cointegration approaches in stock markets, real estate markets and hedge funds, there is not much this kind of research available for shipping market.

There is one technical report on this issue by Magirouet et al.(1997). They started their diversification model with the observation of the correlation between the returns from various types of vessels. Correlation coefficients were high but not perfect, and thus they concluded that there existed some limited possibility for diversification in the structure of fleets. They applied Standard Markowitz Theory to obtain the risk - return tradeoffs between six types of vessels namely Handysize, Panamax, Capesize bulk carriers and Handysize, Aframax, VLCC tankers for the period 1980-1995. They carried out their estimations in a commercial spreadsheet with mathematical programming facilities. The empirical results demonstrated that by using the optimal portfolio, an investor gets a much better risk-return profile than the one provided by restricting the investment to one single vessel.

Grelck et al. (2009) analyzed the diversification properties of investments in shipping for a sample period from January 1999 to December 2007. However, they focused on shipping companies, not the shipping sector in general and estimated the betas of shipping company stocks. The empirical results indicated that shipping stocks do not have a huge equity beta component. And as a result, they possessed the diversification properties craved by alternative investors.

In a different way, Jia and Adland (2002) analysed the time varying nature of the relations between investment returns for five vessels namely; VLCC, product tankers, Capesize bulker, Handymax bulker and Handy container during 1992 to 2002. Their results demonstrated that the correlation of returns in shipping is time varying. Especially, during market downturns, the shipping markets appeared to further strongly correlate. This result indicated that the benefit of diversification is obviously restricted.

To the best of our knowledge, there is only one doctoral thesis, Tsolakis (2005), which examined the possibilities to benefit from diversification in shipping market by cointegration approach. It was employed Johansen cointegration methodology for testing of long run relations in the freight rates of eight different vessel types and sizes. The thesis identified the situations where long run risk reduction benefits can be obtained by investing into different vessel types and sizes for the period 1979-2002. The thesis found that investing in more than one type of bulk carrier did not imply any risk reduction benefits. However, the results also indicated that there is a possibility to reduce risk by investing in more than one type of tankers. In addition, risk reduction benefits decreased as diversification increased with no risk reduction benefits obtained when investment involved more than five different vessel types and sizes.

Veenstra and Franses (1997) have applied cointegration analysis in the shipping industry. However, their aims were to test the efficiency of shipping markets and to forecast freight rates, not to investigate diversification benefits. Their results still give us some insight about relations between freight rates of different vessels, thus we mention the results here. In their study, Veenstra and Franses (1997) proposed a model that represents the structure of freight rates belonging to three Capesize and three Panamax routes for the period 1984-1986. The empirical results of the study indicated that an economically meaningful structure existed in a set of dry bulk freight rates; that is, there are stable long-run relationships between such freight rates. This previous study shows that freight rates within a shipping sector are cointegrated.

In our article, we follow the study of Tsolakis (2005), however, our study is different from this previous study in two aspects. We extend this doctoral thesis with the inclusion of two different vessel sizes. We include Handymax vessel size group for both tankers and dry bulkers in our analyses. Thus, we conduct this study for ten different vessels to investigate diversification effect between them. In addition, our time period is completely different from the previous study. We analyse the diversification effect in the tramp shipping market after 2002, while they conducted this study for before 2002. It is important threefold. First, in this way we can show and compare diversification benefits in the tramp shipping market before and after 2002. Second, the effect and importance of globalization have been increased rapidly in recent years. Increasing globalization leads markets being more integrated. This also leads to decrease the potential of risk reduction benefits for all investors through diversification. With the increasing globalization and interdependence between many markets of the world, diversification effect might have changed over the past decade. For instance, the global financial crisis in 2008 had a broad impact on all shipping industry. Therefore, we can also show the effects of the globalization on diversification effects in shipping market. Lastly, the number and the size of combination carriers have decreased over the last decade. Thus, it might be the case that the relation between dry bulker and tanker markets has decreased.

3. METHODOLOGY

According to Markowitz Diversification Theory, investors combine assets with zero or negative correlations to reduce investment risks. If correlation coefficient of two assets is -1, in another words there are perfectly negatively correlated, the benefit from diversification will be the most. Therefore, a correlation analysis is a simple way of testing whether risk reduction is possible from diversification. Nevertheless, one of the shortcomings of correlation test is that it only gives information about short run dynamics rather than long run dynamics between the assets. Due to the fact that investors in the shipping industry have long term investment horizons, it is essential to investigate the long run dynamics between freight rates of vessels in order to see diversification benefits more clearly. Cointegration analysis allows us to investigate the existence of long run relations between the freight rates of different vessels. Based on such a technique, investors in shipping industry can make sensible long-term investment decisions.

If two or more time series are individually integrated but some linear combination of them has a lower order of integration, then the series are said to be cointegrated. In other words, the linear combination of non-stationary (or integrated) variables reduces their order of integration. The presence of cointegration shows that a stationary long run relationship among the variables is present. In another words, there is long-run equilibrium between the variables. The cointegration methodology adopted in this study is the approach of analyzing multivariate cointegrated systems developed by Johansen and Juselius (1990, 1992, and 1994). Johansen's approaches takes its starting point in the vector autoregression (VAR) of order p given by:

$$y_t = \mu + A_1 y_{t-1} + ... + A_p y_{t-p} + \varepsilon_t \tag{3.1}$$

Where yt is an nx1 vector of non-stationary $I(1)$ variable sand ε_t is an $nx1$ vector of innovations. This VAR can be rewritten as:

$$\Delta y_t = \mu + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t=i} + \varepsilon_t \tag{3.2}$$

where:

$$\Pi = \sum_{i=1}^{p} A_i - I$$

and

$$\Gamma i = - \sum_{j=i+1}^{p} A_j \tag{3.3}$$

If the coefficient matrix Π, which is called the long run matrix, has reduced rank $r < n$, then there exist nxr matrices α and β each with rank r such that $\Pi = \alpha\beta'$ and $\beta' y_t$ is stationary or $I(0)$.

The cointegrating rank is r and each column of β is the cointegrating vector. The α coefficients can be interpreted as measuring the average speed of adjustment toward the cointegrating relationships in the vector error correction model. It can be shown that for a given r, the maximum likelihood estimator of β defines the combination of y_{t-1} that yields the r largest canonical correlations of Δy_t with y_{t-1} after correcting for lagged differences and deterministic variables when present. Johansen proposes two different likelihood ratio tests of the significance of these canonical correlations and thereby the reduced rank of the Π matrix: the trace test and maximum eigenvalue test, expressed as follows respectively:

$$J_{trace} = -T \sum_{i=r+1} \ln(1 - \widehat{\lambda}_i) \tag{3.4}$$

$$J_{\max} = -T \ln(1 - \widehat{\lambda}_{r+1}) \tag{3.5}$$

Where $\widehat{\lambda}_i$ equals to the estimated values of the characteristic roots (eigenvalues) obtained from the estimated Π matrix, r is the numbers of cointegrating vectors, and T equals the number of usable observations. The trace statistics tests the null hypothesis of r cointegrating vectors against the alternative hypothesis of n cointegrating vectors. The maximum eigenvalue statistics, on the other hand, tests the null hypothesis of r cointegrating vectors against the alternative hypothesis of $r + 1$ cointegrating vectors.

4. DATA

In this study, ten different ship types, both tankers and dry bulkers, are analyzed for the period between 01/01/2002 and 12/27/2011. Ten different ships are Hanysize, Handymax, Panamax, Aframax, Suezmax, ULCC tankers and Hanysize, Handymax, Panamax, Capesize bulk carriers. Data series consist of weekly one-year time charter freight rates belonging to these vessels, which are 522 observations.

Table 1 shows summary statistics of one year time charter freight rates in levels for ten different ships. The skewness and kurtosis of time charter rates as well as the value of the Jarque Bera test in Table 1 show that all series deviate from the normal distribution assumption.

Table 1: Summary Statistics of one year time charter freight rates for ten different ships

	BHSIZE	BHMAX	BPMAX	BCAPE	THSIZE
Mean	15925.67	20615.85	27387.26	50431.56	17553.07
Median	13500.00	16625.00	21500.00	36500.00	15100.00
Maximum	42000.00	60000.00	82000.00	186500.0	28000.00
Minimum	6000.000	6350.000	7250.000	11500.00	10000.00
Std. Dev.	8689.130	8689.130	12610.37	18326.63	39498.35
Skewness	1.439513	1.349839	1.468090	1.558261	0.257400
Kurtosis	4.479713	4.026124	4.396474	4.714685	1.528174
Jarque-Bera	227.9040	181.4209	229.9257	275.1996	52.88057
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Obs.	522	522	522	522	522
Sample Period: 01/01/2002-12/27/2011					
	THMAX	TPMAX	TAMAX	TSMAX	TULCC
Mean	19139.46	23181.51	26004.31	34384.58	46393.87
Median	16000.00	20000.00	26000.00	34000.00	45000.00
Maximum	32000.00	37500.00	43500.00	60000.00	90000.00
Minimum	11500.00	13000.00	13500.00	16000.00	19000.00
Std. Dev.	5282.719	5889.923	6949.864	8271.839	17177.13
Skewness	0.354570	0.278177	0.223772	0.069957	0.434382
Kurtosis	1.497070	1.538544	1.675313	1.942482	2.505819
Jarque-Bera	60.06651	53.18706	42.52327	24.74977	21.72750
Probability	0.000000	0.000000	0.000000	0.000004	0.000019
Obs.	522	522	522	522	522
Sample Period: 01/01/2002-12/27/2011					

THSIZE:Handysize Tanker, THMAX:Handymax Tanker, TPMAX:Panamax Tanker, TAMAX: Aframax Tanker, TSMAX: Suezmax Tanker, TULCC: ULCC tanker, BHSIZE: HandysizeBulkcarrier, BHMAX: HandymaxBulkcarrier, BPMAX: PanamaxBulkcarrier, BCAPE: CapesizeBulkcarrier.

It is also interesting to compare the mean value of time charter freight rates with their standard deviation values (unconditional risk). Therefore, in Table 2, we show mean and standard deviations of freight rate in an ascending order to see more clearly the mean and risk relationship of ten different vessels for their own groups (tankers and dry bulkers).

Table 2: Mean and Standard Deviations of Tankers and Dry Bulkers Time Charter Freight Rates in an ascending order

TANKERS			DRY BULKERS		
Vessel type	Std. Dev.	Mean	Vessel type	Std. Dev.	Mean
THSIZE	5283	17553	BHSIZE	8689	15926
THMAX	5890	19139	BHMAX	12610	20616
TPMAX	6950	23182	BPMAX	18327	27387
TAMAX	8272	26004	BCAPE	39498	50432
TSMAX	11025	34385			
TULCC	17177	46394			

The calculations indicate that mean levels of freight rates for larger vessels are higher than smaller ones. In addition, the largest bulk carrier (BCAPE) and the largest tanker (TULCC) have the highest standard deviation values in their own group. That is, time charter rates for larger vessels have the highest volatility. Therefore, overall, the vessel in their own group of higher average freight rates show increased standard deviation, which means higher risk. However, when we compare tankers and dry bulkers together the results are a bit mixed. For instance, although the smallest tankers (THSIZE) average freight rate is higher than the smallest bulk carriers (BHSIZE) average freight rates, its standard deviation is lower than BHSIZE. In addition, a ULCC tanker (TULCC) has much higher average freight rate than Panamax bulk carrier (BPMAX), however risk level of Panamax bulk carrier is higher than ULCC. Furthermore, Handymax bulk carrier shows a much higher risk with just a slight return advantage over Handymax tanker.

5. EMPIRICAL FINDINGS

We first report the correlation coefficients of the time charter freight rates of ten different vessels to see the probability of benefits from diversification for the period 2002-2011 in Table 3. It is obvious that sources of negative correlations are not evident in the tramp shipping industry. We generally observe high positive correlation coefficients among vessels, while only some of those are relatively low correlation coefficients which are marked in boldface. However, there are many freight rates for different cargoes and different vessels, these different freight rates are strongly correlated over time, when seen in a multi-year perspective. This is because a common factor to all sectors in the shipping industry is the level of world economic activity which is likely to affect seaborne trade in wet and dry cargoes together. Positive correlation may stem from the common factor; world economic activity. Things are good or bad more or less in parallel throughout the global shipping market. Therefore, the level of world economic activity typically reflecting the level of all current freight rates in the same way. However, relatively low correlation coefficient for among some vessels might lead to some possibilities for diversification. Lack of complete positive correlation between the freight rates of several types of vessels will definitely lead to some possibilities for diversification, but not much should be expected from it. The low correlation coefficient may suggest that two ships offer diversification opportunities relative to other ship markets, and as a result shipowners and other investors with long investment horizons may diversify between these two markets believing that they will be spreading their risk more effectively.

The correlation coefficients of bulk carriers are in general higher than those of tankers. For instance, the correlation coefficients between Handysize and Handymax bulk carries and Handymax and Panamax bulk carriers are almost perfect (0.982415 and 0.98918 respectively).In addition, generally speaking, the correlation coefficients between smaller tankers and smaller bulk carriers are the lowest and therefore the probability for someone investing in a portfolio comprising a combination of these vessels to achieve risk reduction through diversification is higher.

Table 3: Correlation coefficients between different ten vessels freight rates

	BHSIZE	BHMAX	BPMAX	BCAPE	THSIZE	THMAX	TPMAX	TAMAX	TSMAX	TULCC
BHSIZE	1	0.982415	0.97635	0.959174	0.485842	0.52382	0.473636	0.599085	0.614898	0.673696
BHMAX		1	0.98918	0.973717	0.494611	0.524079	0.474638	0.606334	0.620111	0.658555
BPMAX			1	0.97927	0.448285	0.478118	0.441558	0.581296	0.597774	0.650867
BCAPE				1	0.528363	0.550571	0.508209	0.635503	0.638634	0.690249
THSIZE					1	0.985054	0.949291	0.911321	0.857016	0.798182
THMAX						1	0.961045	0.915251	0.875492	0.815685
TPMAX							1	0.954869	0.924738	0.864951
TAMAX								1	0.958614	0.931516
TSMAX									1	0.949371
TULCC										1

In addition, we also conduct multivariate cointegration analysis as well as correlation analysis to see the possibility of diversification benefits in the shipping industry. As mentioned in the methodology to proceed with cointegration tests, it is needed that series are non-stationary and hence integrated of order 1. In another words, in order to test for cointegration, the first step is to check if each series is integrated of the same order. Because, some of the series are not stationary, but I(1). In most of the cases linear combinations of non-stationary series result in non –stationary series I(1). But when talking about cointegration, then the combination of two series I(1) results in a I(0) series. And if two variables are cointegrated, then there is a long-term relationship between them, and on short term, one can deviate from the other, but as they are cointegrated on a long-term we can find an equilibrium relationship. Therefore, we conduct Augmented Dickey Fuller (ADF) and Phillips and Perron (PP) unit root tests. ADF and PP unit root test results in Table 4 suggest that levels of all series are non-stationary, while their first differences are stationary, indicating that variables are in fact integrated of first order I(1). This result allows us to proceed with cointegration analysis.

Table 4: ADF and PP Stationary Test Results

	BHSIZE	BHMAX	BPMAX	BCAPE	THSIZE
	ADF TEST RESULTS				
Level					
Intercept	-2.0059	-2.07913	-2.42696	-2.46298	-1.02344
trend&inter	-1.8628	-1.97802	-2.38589	-2.42721	-1.31200
1st difference					
Intercept	-10.4283*	-13.9246*	-7.51799*	-13.271*	-21.0445*
trend&inter	-10.4589*	-13.9559*	-7.54323*	-13.286*	-21.1245*
	PHILIPS PERRON TEST RESULTS				
Level					
Intercept	-2.08358	-2.06694	-2.17181	-2.04487	-1.160841
trend&inter	-1.9417	-1.9300	-2.06653	-1.99240	-1.40518
1st difference					
Intercept	-14.6836*	-14.2120*	-23.2107*	-21.877*	-21.1116*
trend&inter	-14.7006*	-14.2395*	-23.1925*	-21.876*	-21.1706*

*denotes significance at %1 level, t statistics of ADF and PP tests

	THMAX	TPMAX	TAMAX	TSMAX	TULCC
	ADF TEST RESULTS				
Level					
Intercept	-1.20720	-1.229794	-1.50019	-1.41500	-1.45738
trend&inter	-1.34823	-1.34829	-1.74211	-1.47823	-1.47850
1st difference					
Intercept	-18.830*	-13.1988*	-9.09335*	-19.2761*	-20.6326*
trend&inter	-18.892*	-13.3154*	-9.19188*	-19.3920*	-20.6870*
	PHILIPS PERRON TEST RESULTS				
Level					
Intercept	-1.21742	-1.16063	-1.31750	-1.49717	-1.78492
trend&inter	-1.32978	-1.33286	-1.53140	-1.51853	-1.78506
1st difference					
Intercept	-18.9052*	-21.1475*	-18.9830*	-19.5114*	-20.8002*
trend&inter	-18.9413*	-21.1370*	-18.9914*	-19.5376*	-20.8435*

*denotes significance at %1 level, t statistics of ADF and PP tests

Vessel portfolio can consist of two, three, four, five, six, seven, eight, nine or all vessels. In our analysis, all possible combinations have been examined. To calculate all combinations, it has been used the binominal coefficient model for n (10) elements of k-combinatios. (eq.5.1) Thus, according to equation 5.1, totally 1013 possible fleet combinations have been derived for ten vessels.

$$\binom{n}{k} = \frac{n!}{k!(n-k)!} \tag{5.1}$$

Based on Johansen multivariate cointegration methodology, all these 1013 different combinations have been tested for the existence of long run relations. Every time we conduct the cointegration test for these 1013 combinations, we determine the optimal lag length by using VAR models and based on AIC (Akaike Information Criteria). The characteristics of the cointegration vectors and of the tested series have been chosen based on Log Likelihood, AIC and SCI criteria according to the summary of 5 different models. In the Johansen test there are 5 types of models that can be tested. There might be different models for all 1013 combinations. The characteristics of the cointegration vectors and of the tested series might change depending on the combinations. There might be no deterministic trend of y and no constant in the variables of the cointegration vector for some combinations, there might be no deterministic trend of y and the variables in the cointegration vector vary around a constant for some combinations and so on.

Table 5: Two vessel diversified fleet Ho: r=0 and H1: r=1
(Non-Rejection of null hypothesis for 33 combinations out of 45 combinations)

	Trace statistic	Prob.	Max-Eigen Statistic	Prob.
Thsize-Thmax	16.58631	0.1487	15.31732	0.0614
Thsize-Tpmax	15.25930	0.2119	14.19938	0.0905
Thsize-Tamax	15.10612	0.2203	13.99281	0.0971
Thsize-Tsmax	10.33559	0.6068	9.288707	0.4035
Thsize-Tulxx	13.48491	0.3264	12.27531	0.1706
Thsize-Bhsize	6.546027	0.9238	5.305653	0.8604
Thsize-Bhmax	7.040748	0.8946	5.834022	0.8062
Thsize-Bpmax	5.376544	0.9720	4.151449	0.9492
Thsize-Bcape	7.044169	0.8944	5.855923	0.8039

Trace statistics and Max-Eigen Statistics at 5%: 20.2618 and 15.89210 respectively.

	Trace statistic	Prob.	Max-Eigen Statistic	Prob.
Thmax-Tpmax	14.64834	0.2472	13.3227	0.1216
Thmax-Tamax	13.62813	0.3158	12.41403	0.1632
Thmax-Tsmax	10.21139	0.6190	8.891549	0.4455
Thmax-Tulxx	11.91701	0.4562	10.51304	0.2899
Thmax-Bhsize	6.42377	0.9302	5.041540	0.8847
Thmax-Bhmax	7.107956	0.8903	5.713960	0.8191
Thmax-Bpmax	5.474393	0.9690	4.064486	0.9540
Thmax-Bcape	7.003852	0.8970	5.603644	0.8307
Tpmax-Bhmax	9.616368	0.6774	7.747922	0.5780
Tpmax-Bpmax	7.779212	0.8420	5.681609	0.8225
Tpmax-Bcape	9.859473	0.6536	7.857782	0.5648
Tpmax-Bhsize	8.381433	0.7922	6.503323	0.7246
Tamax-Bhsize	13.06402	0.3588	9.513969	0.3807
Tamax-Bhmax	14.72212	0.2427	11.46810	0.2190
Tamax-Bpmax	14.17779	0.2774	9.933868	0.3403
Tamax-Bcape	15.53778	0.1971	11.99041	0.1865
Tsmax-Bhsize	11.44741	0.4996	7.651980	0.5897
Tsmax-Bhmax	12.72375	0.3863	9.073157	0.4260
Tsmax-Bpmax	11.35409	0.5083	7.285298	0.6346
Tsmax-Bcape	13.21905	0.3466	9.414086	0.3907
Tulcc-Bhsize	16.74555	0.1423	11.49134	0.2175
Tulcc-Bhmax	18.15257	0.0951	13.35175	0.1204
Tulcc-Bpmax	17.55358	0.1132	12.77500	0.1454
Tpmax-Bhsize	8.381433	0.7922	6.503323	0.7296

Trace statistics and Max-Eigen Statistics at 5%: 20.2618 and 15.89210 respectively.

We only report the cointegration results for the non-rejection of the null hypothesis, which tell us that no cointegration exists between the vessel freight rates under investigation. (see tables 5, 6 and 7). Because the non-existence of this relationship between vessels implies that there might be a benefit from diversification with the building of fleet that combines of them. In another way, the acceptance of the hypothesis H0 shows that there is no cointegration relationship for the series in a combination.

Table 6: Three vessel diversified fleet Ho: r=0 and H1: r=1
(Non-Rejection of null hypothesis for 27 combinations out of 120 combinations)

	Trace statistic	Prob.	Max-Eigen Statistic	Prob.
Thsize-Thmax-Tamax	29.86179	0.1678	16.63818	0.2553
Thsize-Thmax-Tsmax	26.64786	0.3069	16.31510	0.2765
Thsize-Thmax-Tulcc	27.93391	0.2443	15.84043	0.3097
Thsize-Thmax-Bhsize	23.62578	0.4870	17.05154	0.2300
Thsize-Thmax-Bhmax	22.69018	0.5490	15.69843	0.3202
Thsize-Thmax-Bpmax	21.46015	0.6317	16.03438	0.2958
Thsize-Thmax-Bcape	22.52917	0.5598	15.69009	0.3208
Thsize-Tpmax-Bhsize	23.93392	0.4670	16.63206	0.2557
Thsize-Tpmax-Bhmax	25.97225	0.3435	17.63269	0.1977
Thsize-Tpmax-Bpmax	25.08294	0.3952	18.46651	0.1577
Thsize-Tpmax-Bcape	27.25005	0.2764	18.47545	0.1572
Thsize-Tsmax-Bhsize	22.19837	0.5821	13.82300	0.4783
Thsize-Tsmax-Bhmax	24.21823	0.4488	14.63858	0.4053
Thsize-Tsmax-Bpmax	35.19275	0.3974	17.13316	0.2252
Thsize-Tsmax-Bcape	25.91051	0.3469	15.59537	0.3280

Trace statistics and Max-Eigen Statistics at 5%: 35.19270 and 22.29962 respectively.

	Trace statistic	Prob.	Max-Eigen Statistic	Prob.
Thsize-Bhsize-Bpmax	29.46869	0.1817	21.85190	0.0576
Thmax-Tpmax-Bhsize	28.89040	0.2037	20.47314	0.0881
Thmax-Tpmax-Bhmax	29.02123	0.1986	19.54372	0.1161
Thmax-Tpmax-Bpmax	29.78689	0.1704	21.97692	0.0554
Thmax-Tpmax-Bcape	30.97819	0.1328	21.09709	0.0729
Thmax-Tsmax-Bhsize	24.80841	0.4119	15.69305	0.3206
Thmax-Tsmax-Bhmax	25.91295	0.3468	15.61747	0.3263
Thmax-Tsmax-Bpmax	28.24613	0.2305	19.40281	0.1209
Thmax-Tsmax-Bcape	29.25023	0.1898	17.93335	0.1824
Thmax-Bhsize_bpmax	28.86991	0.2045	21.34373	0. 0676
Tamax-Bhsize-Bpmax	31.45541	0.1198	17.19650	0. 2215
Tulcc-Bhsize-Bpmax	34.07804	0.0656	17.45525	0.2071

Trace statistics and Max-Eigen Statistics at 5%: 35.19270 and 22.29962 respectively.

Table 7: Four vessel diversified fleet Ho: r=0 and H1: r=1
(Non-Rejection of null hypothesis for 14 combinations out of 210 combinations)

	Trace statistic	Prob.	Max-Eigen Statistic	Prob.
Thsize-Thmax-Tsmax-Bhsize	46.39663	0.2021	21.52346	0.3047
Thsize-Thmax-Tsmax-Bhmax	44.53381	0.2670	18.13087	0.5646
Thsize-Thmax-Tsmax-Bpmax	47.69362	0.1641	21.33232	0.3171
Thsize-Thmax-Tsmax-Bcape	48.63447	0.1400	20.70613	0.3600
Thsize-Thmax-Tulcc-Bhsize	52.19320	0.0729	28.58808	0.1643
Thsize-Thmax-Tulcc-Bhmax	50.42576	0.1018	23.94590	0.1753
Thsize-Thmax-Bhsize-Bhmax	49.85011	0.1131	26.9388	0.0800
Thsize-Tpmax-Bhsize-Bhmax	52.17347	0.0732	27.83976	0.0621
Thsize-Tpmax-Bhsize-Bpmax	49.20360	0.1269	26.44286	0.0917
Thsize-Tpmax-Bhsize-Bcape	54.03973	0.0504	28.95461	0.0549
Thsize-Tsmax-Bhsize-Bhmax	51.90161	0.0772	31.34595	0.0216
Thsize-Tsmax-Bhsize-Bpmax	50.93281	0.0927	31.15474	0.0230
Tamax-Tsmax-Bhsize-Bpmax	55.04284	0.0409	23.64531	0.1885
Tamax-Tulcc-Bhsize-Bpmax	56.61712	0.0292	25.59145	0.1152

Trace statistics and Max-Eigen Statistics at 5%: 54.07904 and 28.58808 respectively.

According to the cointegration test results diversification benefits are existent in the combination of at most four different vessels. After that, say for example the fleet consisting of five, six, seven and more vessels does not lead to risk reduction from diversification. According to the Markowitz Portfolio Theory higher diversification increases the risk reduction benefits. However, the literature also indicates us that the marginal benefits to diversification tend to decrease as the company diversifies further away from its basic business. This might be the explanation of some companies, which focus on one or two vessel types, being more successful than some others which tend to operate much diversified fleet.

When we look at trace and eigenvalue statistics in Table 5, 6 and 7, they show that we can accept the null hypothesis, which means no cointegration exists, for 33, 27 and 14 combinations out of 45, 120 and 210 different combinations consisting of two, three and four vessels respectively. For all other combinations there is at least one cointegrating vector between the freight rates, therefore the risk reduction benefit does not exist through diversification in the long run. The summary results of all these 1013 cointegration tests can be seen in Table 8.

Table 8: Cointegration tests summary results of all possible combinations

Number of vessels in diversified fleet	Diversified fleet combinations	The number of non-rejection of the null hypothesis	%
2	45	33	73.3
3	120	27	22.5

Number of vessels in diversified fleet	Diversified fleet combinations	The number of non-rejection of the null hypothesis	%
4	210	14	6.7
5	252	0	0
6	210	0	0
7	120	0	0
8	45	0	0
9	10	0	0
10	1	0	0

6. CONCLUSION

In the shipping industry, there are some companies that tend to operate a diversified fleet as well as some companies that tend to focus on one or two shipping segments. An obvious question here is whether the tramp shipping industry can really benefit from diversification? The aim of this paper is to analyze the potential of risk reduction benefits for a tramp shipping investor through diversification. Multivariate cointegration as well as correlation analysis is used in order to achieve this aim. Both analyses indicate that risk reduction benefits can be achieved from diversification in the tramp shipping market, whereas very restrictive. According to correlation coefficient results, negative correlations are not evident in the tramp shipping industry. We generally observe high positive correlation coefficients among freight rates of different vessels, while only some of those have relatively low correlation coefficients. Relatively low correlation coefficients for among some vessels might be leading to some possibilities for diversification. Lack of complete correlation between the performances of several types of vessels will definitely lead to some possibilities for diversification, but not much should be expected from it.

Correlation coefficients are indeed extremely sensitive to short term movements; they have a shorter term connotation as compared to cointegration analysis. Cointegration measures common movements during longer periods of time and thus it is not affected by short term movements. Therefore, we conduct cointegration analysis to see the possibility of diversification benefits for the long term investment horizon in the shipping industry. Multivariate cointegration method has been employed on 1013 different combinations of investment in the dry bulkers and tankers. Cointegration results of 74 cases out of 1013 cases showed the possibilities of risk reduction benefits through investing into different vessel types and sizes. In detail, the results show that investing in more than one type of bulk carrier has not any risk reduction benefits. If the vessels are dry bulkers, the diversification does not lead to risk reduction. However, the results also indicated that there is a possibility to reduce risk by investing in more than one type of tankers. Moreover, there is no risk reduction benefits obtained when investment involves more than four different vessel types and sizes. During the global financial crises, some companies that focus on one or two vessel types have been more successful than some others that tent to operate much diversified fleet. Our empirical results are in line with this situation. In contrast to traditional portfolio theory, increased diversification does not lead to a risk reduction in the shipping industry. It might be because the income of the various vessel types and sizes is strongly correlated. It also might be due to the fact that the industry needs more expertness than other industries, which lead to focus on one or more shipping segments. The literature tells us that the marginal benefits to diversification tend to decrease as the company diversifies further away from its basic business.

In this way we try to develop a practical guide to the ship investors and shipping company managers seeking risk reduction benefits through diversification.

Acknowledgement 1. *We would like to thank the Finance and Banking (FI BA) 2013 committee very much for organizing and giving us the opportunity to attend this beneficial conference. This work was also supported by Scientific Research Projects Coordination Unit of Istanbul University. Project Number: 26812 (YADOP)*

References

[1] Adjaoute, K., & Danthine, J. P. (2001). EMU and portfolio diversification opportunities. FAME research paper no. 31.

[2] Franses, P.H.B.F. &Veenstra, A.W. (1997). A co-integration approach to forecasting freight rates in the dry bulk shipping sector. Transportation Research. Part A, 31, 447-458.

[3] Füss, R. & Kaiser, D.G. (2009). Dynamic Linkages between Hedge Funds and Traditional Financial Assets: Evidence from Emerging Markets. European Business School Research Paper Series 09-19, electronic copy available at: http://ssrn.com/abstract=1112247.

[4] Gallo, J.G., Lockwood L.J. & Zhang, Y. (2013). Structuring Global Property Portfolios:A Cointegration Approach.Journal of Real Estate Research, 34,53-82.

[5] Girard, E. & Ferreira, E. J. (2004). On the Evolution of Inter- and Intra Regional Linkages to Middle East and North African Capital Markets. Quarterly Journal of Business and Economics, 43(1/2), 21-43.

[6] Gregoriou, G.N. & Rouah, F. (2001). Do Stock Market Indices Move the Ten Largest Hedge Funds? A Cointegration Approach. Journal of Alternative Investments, 4(2), 61-66.

[7] Grelck, M.B., Prigge, S., Tegtmeier, L. & Topalov, M. (2009). Diversification Properties of Investments in Shipping, the Journal of Alternative Investments, 12(1), 55-74.

[8] Hitt, M.A., Ireland, d. & Hoskisson, R.E. 1999.Strategic Management: Competitiveness and Globalization: Cases, Cengage Learning.

[9] Hjalmarsson E. (2007). Testing for Cointegration Using the Johansen Methodology when Variables are Near-Integrated. No.915, Board of Governors of the Federal Reserve System International Finance Discussion Papers.

[10] Jia, J., & Adland, R. (2002). An Empirical Analysis of the Time-varying Correlation of Returns in International Shipping. Conference of the International Association of Maritime.

[11] Johansen, S. & K. Juselius (1990). Maximum Likelihood Estimation and Inference onCointegration with Applications to the Demand for Money. Oxford Bulletin of Economics and Statistics, 52(2), 169-210.

[12] Johansen, S. & K. Juselius (1992). Testing Structural Hypothesis in a Multivariate Cointegration Analysis of the PPP and the UIP for UK. Journal of Econometrics, 53(1-3), 211-244.

[13] Johansen, S. & K. Juselius (1994). Identification of the Long-Run and the Short-Run Structure: An Application to the ISLM model. Journal of Econometrics, 63(1), 7-36.

[14] Kanas, A. (1998). Linkages between the US and European Equity Markets: Further Evidence from Cointegration Tests. Applied Financial Economics, 8, 607-614.

[15] Kazi, M. H. (2008). Is Australian Stock Market Integrated to the Equity Markets of its Major Trading Partners?. International Review of Business Research Papers, 14(5), 247-257.

[16] Kempa, B., & Nelles, M. (2001). International correlations and excess returns in European stock markets: Does EMU matter? Applied Financial Economics, 11(1), 69–73.

[17] Liow, K.H. & Yang, H. (2005). Long-Term Co-Memories and Short-Run Adjustment:Securitized Real Estate and Stock Markets. The Journal of Real Estate Finance and Economics. 31(3), 283–300.

[18] Majid, M. S. A., Meera, A. K. M., Omar, M. A. & Aziz, H. A. (2009). Dynamic Linkages Among ASEAN-5 Emerging Stock Markets. International Journal of Emerging Markets, 4(2), 164-184.

[19] Markowitz, H. (1952). Portfolio Selection. The Journal of Finance, 7(1), 77-91.

[20] Skjetne, R. A., (2005). Applied Financial Risk Management for the Shipping Industry Using IMAREX Derivatives. Norwegian School of Economics and Business Administration, Master Thesis, Bergen.

[21] Tsolakis, S. (2005). Econometrics Analysis of Bulk Shipping Markets Implications for Investment Strategies and Financial Decision Making. Unpublished PhD thesis, Erasmus University, Rotterdam, The Netherlands. Electronic copy available at: http://repub.eur.nl/res/pub/6717/Phd_Stavros_Tsolakis_9June05.pdf(Accessed 29 March 2012).

[22] Veenstra, A. W. & Franses, P.H. (1997). A Co-Integration Approach To Forecasting Freight Rates in the Dry Bulk Shipping Sector. Trabsportation Research A, 31(6), 447-458.

[23] Wilson, P.J., Gerlach, R. &Zurbruegg, R. (2002). Potential Diversification Benefits in the Presence of Unknown Structural Breaks:An Australian Case Study. Pacific Rim Real Estate Society Conference, January, Christchurch, New Zealand.