COMMON RISK FACTORS IN THE RETURNS OF SHIPPING STOCKS

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March 2009

Abstract

Knowledge of the common risk factors that determine an industry's stock returns is crucial to assess whether this industry serves as a separate asset class. In a first step, it is interesting to estimate the economic risk profile to understand which common factors drive industry stock returns in the short-run. In a second step, asset pricing theory requires to select those systematic factors that command risk premiums and determine industry valuations in the long-run. This study investigates the common risk factors for the shipping industry and its subsectors container, tanker, and bulker shipping. Our sample consists of the monthly returns of 48 publicly-listed shipping companies over the period from January 1999 to December 2007. We use the shipping stocks together with a set of country or other industry equity indices to estimate the risk exposures (economic risk profiles) and the corresponding factor risk premiums. Using a Seemingly Unrelated Regression (SUR) model to estimate the risk sensitivities, we document that shipping stocks exhibit remarkably low stock market betas. We also show evidence that a multi-dimensional definition of risk is necessary to capture the risk-return spectrum of shipping stocks. A one-factor asset pricing model produces large pricing errors and is rejected based on the GMM orthogonality conditions. In contrast, when the change in industrial production, the change in the trade-weighted value of the US-$, and the change in the oil price are added as additional risk factors, this multifactor model is able to price the cross-section of expected stock returns. The global risk profile of the shipping sector, i.e., the sensitivities of shipping stocks against global systematic risk factors, is different to country and other industry equity indices. However, the risk profiles are similar for all three subsectors of the shipping industry. Overall, our results suggest that shipping stocks have the potential to serve as an independent asset class. Furthermore, our findings potentially have important implications for computing the cost of equity capital in the shipping industry.

Key Words: Shipping stocks, risk profile, risk premiums, asset pricing models.

JEL Classification: G12, G11.

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1. INTRODUCTION

An asset class can be determined by its sensitivities to and its co-movements with underlying economic risk factors. A specific industry should be viewed as a separate asset class if its risk profile based on factor sensitivities is sufficiently different from those of other industries. In this paper, we investigate whether the shipping industry has the potential to serve as an attractive new asset class that enhances the risk-return spectrum of a diversified investor. We also examine which economic risk factors are important for the pricing of publicly-listed shipping stocks. Moreover, knowing both the sensitivities to systematic risk factors and the associated risk premiums, there are important implications for the cost of equity capital of these companies.

Analyzing ship markets has a long tradition in economics. Already Koopmans (1939) studied the relationship between freight rates and the construction of oil tankers. Nevertheless, the shipping industry has never received the attention in the literature it deserves given its economic importance. The shipping industry is responsible for the carriage of about 90% of world trade. Without shipping it would be impossible to conduct international trade, the bulk transport of raw materials as well as the import and export of food or manufactured goods. In addition, the operation of ships generates an estimated annual income of almost US-$ 500 billion in freight rates, representing about 5% of the total global economy (International Maritime Organization, 2006). It is the availability, low cost and efficiency of maritime transport that has supported globalization and enabled the massive shift of industrial production to emerging countries. With growing world trade, the shipping industry has enjoyed the longest sustained period of buoyant markets until late 2008. The industry has responded by building new ships, generating new investment opportunities and attracting the interest of investors. This cyclical behavior has clearly attributed to the strength of the current crises in the shipping market.

In spite of the economic importance of the shipping sector, there is surprisingly little previous literature that examines shipping stocks in a rigorous asset pricing context. Grammenous and Marcoulis (1996) use the stock market beta and firm-specific factors to explain the cross section of shipping returns. They report a market beta lower than unity in a sample of 11 shipping companies over the period from 1989 to 1993. Similarly, Kavussanos and Marcoulis (1997a) investigate the market risk on the company level and compare the average beta to the overall US stock market. They cannot detect a significant difference between the average beta of the shipping sector and the S&P 500 during the 1985-1995 period. In another empirical study, Kavussanos and Marcoulis (1997b) compare the return structure of different transportation sectors. They document (i) a stock market beta lower than unity in the water transportation sector and (ii) some explanatory power of accounting data for shipping stock returns, e.g. the assets-to-book ratio. Kavussanos and Marcoulis (1998) stress the observation that the systematic risk of the shipping sector is low, as measured by the explanatory power of market model regressions over the period from 1984 to 1995. In Kavussanos and Marcoulis (2000a, 2000b) macro- and micro-factors are used to explain the cross-section of US transport industry returns. For example, their results reveal explanatory power of the change in industrial production and the change in the oil price. Kavussanos et al. (2003) look at a sample of international shipping stocks to compare the return structure regarding different subsectors of the shipping industry. They cannot find differences in the systematic risks across the subsectors but a beta smaller than unity for most sectors. The estimated alpha often indicates mispricing in the shipping sector. Gong et al. (2006) examine the stability of the beta estimates in the shipping industry under different estimation designs. They employ the Scholes-Williams (1977) approach to account for a potential thin trading bias. The estimated betas are significantly different depending on the estimation technique over the 1984-1995 sample period. They further document that the differences are greater when using daily stock returns rather than monthly returns. Overall, they report betas lower than unity in the water transportation sector. Finally, Kavussanos and Marcoulis (2005) review this strand of the literature. The current consensus seems to be that the returns on shipping stock are related to both firm-specific and common macroeconomic factors.

These results from the previous literature are important because one would expect that investors are concerned about the risk profile of shipping stocks in their asset allocation decisions. The risk profile of shipping stocks indicates how they react to contemporaneous changes in economy-wide risk factors, e.g., exchange rate changes, changes in interest rates, and changes in the oil price, among others. More specifically, knowledge of the risk factors and the factor sensitivities is important for the following applications:

Fundamental analysis: Factor sensitivities (exposures) and the explanatory power of factor models provide information on the economic determinants of stock return volatility. This enables an efficient allocation of resources in the data gathering and transformation process of financial analysis.

Diversification: The cross-sectional patterns of factor risk profiles provide valuable information on the diversification effects across industries. A well-diversified portfolio takes into account not only the idiosyncratic risk of individual stocks or entire industries, but also the various risk factors—and the factor exposures provide the necessary information.

Pricing potential: Cross-sectional differences in expected returns can be related to risk factors if their respective factor exposures differ across stocks and are different from zero.

Hedging: Because the factor sensitivities incorporate the correlation between stocks and the corresponding risk factor, factor exposures are the basis for minimum-variance hedging strategies.

In this paper, we address the first three questions. In a first step, we examine the risk-return profile of stocks from the three subsectors of the shipping industry: bulker, tanker and container services. In the spirit of international asset pricing tests (Harvey, 1991; Ferson and Harvey, 1993; Dumas and Solnik, 1995), we consistently apply aggregate information about potential global sources of systematic risk. This choice assumes that global stock markets are integrated, i.e., stocks denominated in different currencies and/or from different countries exhibit the same risk-adjusted expected returns (Bekaert and Harvey, 1995). If shipping stocks load to different risk factors than the aggregate market or industry indices, they presumably offer diversification benefit for an investor by enhancing the risk-return spectrum. In other words, shipping stocks constitute a separate asset class.

A caveat is that shipping stocks are only one out of several investment vehicles that allow an investor to participate in the economic cycles of the shipping sector. One prominent example for an alternative way to bundle exposure to ships is a closed-end ship fund, e.g., under the German-KG-model.[1] In fact, in a risk-return spectrum the investment opportunities into ships are broad: they range from the Schiffspfandbrief and corporate bonds, managed trusts and closed-end ship funds to freight derivatives and shipping hedge funds. Based on their risk-adjusted performance potential, shipping stocks are presumably in the middle of this range. The main advantage of using shipping stocks in our empirical analysis is that reliable price data are available on a daily basis.

In a second step, we go one step further than the previous empirical shipping literature and conduct an asset pricing test. Following Ferson and Harvey (1994), we examine the pricing potential of the predefined risk factors and simultaneously estimate factor sensitivities and the corresponding factor risk premiums. The underlying notion is that if the factors are sources of systematic risk, an investor earns a premium for taking over this type of risk. The empirical results are important for two main reasons: First, from an investor's perspective, they indicate the performance attributes of shipping stocks and the sources of expected returns. Second, from a company's perspective the results have implications for the cost of equity capital. This is a required input parameter for the valuation of ships and, more generally, any project in the shipping industry.

We use a sample of 48 publicly-listed shipping companies that are classified into the three main subsectors of the shipping market. To estimate the risk profiles of the shipping sector and compare them with other industries, we construct indices of the single stocks. Country and industry indices are used as proxies for alternative asset classes. In a first step, we run a regression of the returns on a broad stock market factor and test for differences in the estimated betas. In a second step, we extend the regression analysis to include a set of economic risk factors which presumably have a pricing impact. The estimated sensitivities (factor exposures) indicate the risk profile of ships as a potential asset class. In a third step, we estimate the exposures on these risk factors and the corresponding risk premiums simultaneously in a system of equations using Hansen's (1982) Generalized Method of Moments (GMM). This approach allows us to examine the attributes of expected returns on shipping stocks.

In line with former research, we document that shipping stocks exhibit remarkably low stock market betas. We also find that shipping stocks exhibit a unique risk-return spectrum compared to other investments. For the set of spanning assets that consists of shipping stocks and country or sector indices a one-factor model leads to large pricing errors and, hence, is rejected based on the GMM orthogonality conditions. In contrast, when the change in industrial production, the change in the trade-weighted value of the US-$ and the change in the oil price are added as additional risk factors, this multifactor model is able to price the cross-section of expected stock returns. The global risk profile of the shipping sector, i.e., the sensitivities of shipping stocks to systematic risk factors, is different to country indices and other industry indices. However, the risk profiles are similar for all three subsectors of the shipping industry.

The remainder of this paper is structured as follows. Section 2 describes our empirical methodology, and section 3 presents our data. In section 4, we discuss our empirical findings. The paper closes in section 5 with a conclusion and an outlook for further research.

[1] See Bessler, Drobetz and Seidel (2008) for an analysis of the German-KG-model.

2. EMPIRICAL METHODOLOGY

According to the CAPM of Sharpe (1964), Lintner (1965), and Mossin (1966), the expected return on a firm's equity can be explained as a linear function of a single risk factor, i.e., the expected return on the market portfolio. In the empirical asset pricing literature, the proxy for this market return is taken to represent a broad measure of stock market returns (e.g., the MSCI World Stock Market Index). Extensions of this model use either portfolio returns, such as the returns on size, value or momentum portfolios (Fama and French (1993), Carhart (1997)), or macroeconomic variables (Chen et al. (1986), Ferson and Harvey (1994)) as proxies for additional sources of priced risk. We follow the latter approach and examine the risk-return structure of stock returns in the shipping industry. The macroeconomic shocks can be seen as shocks to the stream of expected earnings and constitute – on an abstract level – proxies for the future economic environment. We expect that a set of global macroeconomic variables has an impact on the expected stock returns in the shipping industry that cannot be explained by the stock market factor alone. Overall, our analysis leads us to a deeper understanding of the risk-return profile of shipping stocks.

In our empirical analysis, we use an unconditional beta pricing model to examine the structure of returns across shipping stock and subsectors of the shipping industry. Analyzing the pricing potential of global risk factor in an unconditional framework is particularly useful from the viewpoint of investors who think in terms of constant long-run compensations for taking over multidimensional risks. Our valuation framework is consistent with the Arbitrage Pricing Theory (APT) developed by Ross (1976), Huberman (1982), Chamberlain (1983), Chamberlain and Rothschild (1983), and Ingersoll (1984), among others. A theoretical foundation for using the APT in an international context is provided by Solnik (1983) and Ikeda (1991). Their models suggest that multiple international risk factors have an impact on long-term expected returns and on standard deviations of international assets and that only global factors represent sources of systematic risk. A set of observable economic factors is a valid representation of the true factor structure driving stock returns. The assumptions that are required to use an international beta pricing model are rather strong. Most important, one has to assume that the national equity markets (and the sector markets aggregated over the national barriers) are perfectly integrated and that there are no distorting taxes or transaction costs. Only under these assumptions a set of global risk factors is sufficient to capture the pricing restrictions; otherwise local risk factors must be used too. However, our approach is justified based on previous empirical findings. For example, Bekaert and Harvey (1995) find evidence that the degree of integration on international stock markets is rising. De Santis and Gérad (1997) deny the pricing potential of national risk factors in an international context. Their results strongly emphasize the importance of global risk factors.

To examine the risk profile of the shipping sector, we use the methodology of Ferson and Harvey (1994). Their model assumes that the excess return on an asset is determined by k risk factors:

$$r_{it} = \alpha_{it} + \sum_{j=1}^{K} \beta_{ij} F_{jt} + u_{it} \tag{1}$$

where r_{it} is the continuously compounded excess return on shipping stock i over the risk free-rate in period t-1 to t. The β_{ij}s are the sensitivities (exposures) or betas against the risk factors F_{jt}. They relate to systematic risk, which earns a risk premium; this is in contrast to u_{it}, which is the unsystematic risk or error term that is not rewarded in an asset pricing context.

In a first step, we estimate the market model and only use a stock market factor in order to examine if the beta coefficients are different between the subsectors of the shipping industry and to compare them with the betas of country and industry equity indices. We test the null hypothesis that all beta coefficients are equal across the shipping subsectors as well as across all stock market indices.

The β is a measure of a stock's sensitivity to changes in the stock market return. A stock with a β greater than one carries above average covariance risk, implying that an investor would require a higher expected return to hold it, and vice versa. Moreover, the CAPM suggests that correct pricing over the cross-section of stock returns implies that α (the intercept term) is zero. A negative α indicates that the stock is overpriced, i.e., its return is higher than expected on the basis of the CAPM. In contrast, a positive α indicates that the stock is underpriced, i.e., its return is lower than implied by the CAPM.

In a second step, we examine additional risk factors that are described in more detail in section 3. We regress a set of risk factors F_{jt}, with j=1,…, K, on excess stock returns and examine the resulting risk profile. We use Zellners (1962) Seemingly Unrelated Regressions (SUR) technique that allows for contemporaneous shocks across the equations. The resulting coefficients are the same as in the simple OLS framework, but the standard errors are more efficient.

In the third step, we use a fully-fledged asset pricing model to analyze the cross-section of stock returns. Specifically, we follow the model proposed in Ferson and Harvey (1994). This model is able to estimate the factor sensitivities (betas) and the risk premiums simultaneously. The asset pricing model for expected returns is:

$$E(r_i) = \sum_{j=1}^{K} \beta_{ij}\lambda_j \qquad i = 1, \dots, N, \tag{2}$$

where λ_j is the risk premium of factor j. The interpretation of the beta coefficients is economically the same as in model (1). We estimate the specification in (2) as follows:

$$r_{it} = \sum_{j=1}^{K} \beta_{ij}\left(f_{jt} + \lambda_j\right) + u_{it}, \qquad i = 1, \dots, N, \tag{3}$$

with f_{it} as the demeaned risk factors F_{it}. We implicitly assume that the intercept term is equal to zero.[2] To estimate equation (3), we use Hansen's (1982) Generalized Methods of Moments (GMM). This technique does not require strong assumptions on the data generating process. The data has to follow a strictly stationary and ergodic stochastic process. The error terms do not have to be normally distributed.

[2] Using the demeaned factors, we do not need to assume that the factor means are related to the risk premiums.

The system of equations in (3) has the moment conditions $\mathrm{E}(\mathrm{u}_{\mathrm{it}}) = 0$ and $\mathrm{E}(\mathrm{u}_{\mathrm{it}}\mathrm{F}_{\mathrm{jt}}) = 0$. While the first moment condition is common from standard regression models, the second expectation captures the asset pricing condition: It requires that all information in a specific risk factor F_{jt} is pricing relevant, i.e., there is no information that correlates with the error term. In other words, all information contained in F_{jt} is pricing relevant and is exploited in the GMM-estimation of betas and risk premiums. We use a vector of ones and the contemporaneous values of the risk factors as instruments. The weighting matrix in the quadratic form accounts for heteroskedasticity and serial correlation. Moreover, we use a 2-step GMM-estimation procedure (see Cochrane (2005)) for further details on the estimation method).

3. DATA

3.1. Shipping stocks and common investments

Our empirical work focuses on the container, tanker, and bulker sector of the shipping industry. These three subsectors represent approximately 90% of the world fleet measured by deadweight. Our sample is based on the stocks of container, tanker, and bulker companies that are included in the following indices and stock lists: the Clarkson Liner Share Price Index, the Clarkson Tanker Share Price Index, and Dry Bulk Insight, a monthly report published by Drewry Publications. In addition, we consulted the shipping news service Trade Winds. We identified a group of 48 stocks with a sufficient length of available data (minimum of 36 monthly observations) over the period from January 1999 to December 2007. From these 48 companies, 6 are represented in two or all three subsectors.[3] The stock prices are taken from Thomson Financial DataStream; they are on a US-$ basis and adjusted for capital actions and dividends.

We calculate continuously compounded returns on a monthly basis for each company and the MSCI world index as the proxy for the global market portfolio. Rather than using single stocks, we form portfolios. For each subsector of the shipping industry, we construct a value-weighted and an equally-weighted portfolio. While value-weighted portfolios are more in line with the predictions of the CAPM, the equally-weighted portfolios give more weight to smaller stocks. Apart from our goal to estimate the aggregate risk-return characteristics of the shipping sector, Sercu et al. (2008) report that beta estimations of portfolios are more reliable than of single stocks. By building portfolios we avoid the problem of a possible thin trading bias, which has been reported for small stocks (Dimson (1979), Scholes and Williamson (1977), Gong et al. (2006) for the shipping sector). Thin trading could arise when stocks are not traded continuously. This problem is particularly the case for smaller and illiquid stocks and may, hence, be present in our sample. However, using monthly returns data of broad portfolios should avoid this problem.

In order to compare the results for shipping stocks with other asset classes and to have sufficient spanning assets for the estimation of the risk premiums, we use two sets of indices: (1) the MSCI country indices for the United States, Germany, the United Kingdom and Japan and (2) the 10 MSCI sector indices for energy, materials, industrials, consumer discretionary, consumer staples, health care, financials, information technology, telecommunication services, and utilities (all measured in US-$). To calculate excess returns,

[3] See appendix A for a list of the shipping companies.

we subtracted the short-term country interest rate.[4] Both sets of indices contain roughly the same equities. While the first set sorts according to countries, the second set sorts according to industries. We expect that the risk premiums that are estimated using these two sets as spanning assets do not strongly differ, because they are required to price a similar universe of equities. In other words, it should not affect the estimated risk premiums how the information contained in the underlying equities is being bundled into indices.[5]

The summary statistics of the dependent variables are presented in Table 1. The returns on the shipping stocks during the period from February 1999 to December 2007 are remarkably high compared to the return of both the country and sector indices. For example, the monthly return of 2.16% for the container sector corresponds to a return of roughly 24% per year, while the yearly return in the United States was -1.2% during the sample period. As one would expected for a highly cyclical industry with smaller firms, the volatility of the shipping sector is also higher than that of most of the other indices.

Table 1: Summary statistics - dependent variables

Variable	Observations	Mean	Std. Dev.	Min	Max
Container	107	0.0216	0.0714	-0.1621	0.2120
Tanker	107	0.0289	0.0684	-0.1122	0.2169
Bulker	107	0.0430	0.0947	-0.2035	0.3563
United States	107	-0.0003	0.0397	-0.0972	0.1040
United Kingdom	107	0.0024	0.0392	-0.1238	0.0828
Japan	107	0.0011	0.0525	-0.1201	0.1349
Germany	107	0.0037	0.0652	-0.2048	0.2368
Energy	107	0.0116	0.0532	-0.1616	0.1535
Materials	107	0.0123	0.0538	-0.1356	0.1830
Industrials	107	0.0057	0.0412	-0.1259	0.1163
Consumer Discretionary	107	0.0019	0.0475	-0.1480	0.1307
Consumer Staples	107	0.0031	0.0303	-0.0841	0.0608
Health Care	107	0.0008	0.0334	-0.0865	0.0830
Financials	107	0.0045	0.0424	-0.1118	0.1181
Information Technology	107	0.0016	0.0871	-0.2538	0.2321
Telecommunication Services	107	0.0007	0.0593	-0.1794	0.2076
Utilities	107	0.0061	0.0356	-0.1150	0.0848

3.2. Global risk factors

The global factors ought to represent possible pervasive sources of risk for international investments. We consistently apply aggregate information on potential global sources of systematic risk. Three of the nine global factors are constructed by aggregating economic data from the G-7 countries. These major industrialized countries are Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States. The remaining six

4 We use the yield on 3-month treasury bills for the US, the shipping indices, and the sector indices, while we apply a local short-term interest rate for the other country indices.

5 Cavaglia et al. (2000) and Gerard (2002) provide a discussion of the benefits of country versus sector indices for asset allocation.

(non-G7) risk factors are derived from economic and financial time-series representing information on global aggregates. The risk factors we use are common in the asset pricing literature, e.g., Ferson and Harvey (1994) and Drobetz et al. (2002). All time series are taken from DataStream. The standard models of international asset pricing theory motivate some of these risk factors (Adler and Dumas (1983), Sercu (1980), Solnik (1974), Stulz (1981a)). Earlier empirical studies on multibeta asset pricing in the international environment provide further guidelines for our model (Brown and Otsuki (1993), Dumas and Solnik (1995), Ferson and Harvey (1993), Harvey et al. (1994), Harvey (1995)). Finally, empirical research on the pricing of risks on national stock and bond markets influences our strategy of factor selection (Chen et al. (1986), Fama and French (1993), Elton et al. (1995), Ferson and Korajczyk (1995)).

We use the log change of the MSCI world market index as the global stock market proxy. This variable is denoted as dWmrkE. The MSCI World index is a broad equity index of 22 developed countries, whose market capitalization represents roughly 90% of the total world stock market capitalization.

The monthly log changes of a weighted currency basket, labeled dCurb, consist of the exchange rates between the US-$ and the Euro, Canadian dollar, Japanese yen, British pound, Swiss franc, Australian dollar, and Swedish krona. The weights are derived from the relative trade position of the US against the corresponding country. The monthly log changes of this currency basket mirror changes in the external value of the US-$, which is the lead currency in the shipping industry. Dumas and Solnik (1995) and De Santis and Gérard (1998) document that currency risk is pricing relevant in international factor models. Ferson and Harvey (1994) note that one implicitly assumes that relative purchasing power parity holds if currency risk is excluded.[6]

We expect that shipping stocks are sensitive to variations in international economic activity and international trade. To proxy for these influences, we use two additional factors in our empirical tests: the change in the industrial production in the G-7 countries and the change in the industrial production in China. The change in the G-7 industrial production (dIPG7) is the weighted-average of the contemporaneous log changes of monthly industrial production in these countries. The change in the Chinese industrial production (dIP-China) is the contemporaneous monthly log change of industrial production.

Previous studies in the asset pricing literature document that stock returns are sensitive to risk factors that are condensed out of interest rates (Harvey (1991), Ferson and Harvey (1994)). We use a measure for the short-term interest rates, the long-term interest rates, and the TED spread (i.e., the difference between the interbank lending rate and the risk-free rate). The short- and long-term G-7 interest rates (d3MIG7 and d10yIG7) are proxied by the yields on 3-month and 10-year government bonds, respectively. We weight the interest rates of the G-7 countries according to their share in the G-7 BIP in the previous quarter. The TED spread (dTed) is defined as the difference between the 3-months Eurodollar rate and the yield on the 90-days U.S. T-bill. We use monthly log changes of the TED spread. The TED spread is affected by three factors: (i) world political stability, (ii) balance of trade, and (iii) fiscal policy of the United States (Ferson and Harvey 1993). When political uncertainty is high and the risk of disruption in the global financial system increases, the yield differential widens. When the balance of trade is decreasing, the TED

[6] For a theoretical derivation see Stulz (1981b).

spread also rises. Presumably, the TED spread is an indicator of the current health of the economy. The yield differential should be higher during phases of economic recessions (when investors are seeking safer assets), and it decreases during expansionary phases.

Inflation is another factor that is related to interest rates. Inflation is a proxy for the overall state of the economy. We use a measure derived from the G-7 producer price index (InflG7). Many products transported by ships are pre-products that are finished at the place of destination. The price determines the demand for these products, and hence inflation presumably has an influence on the shipping sector.

The oil price could be a return driver for the shipping industry for two reasons. First, oil is the main input factor for producing carriage service. Second, oil is the main product of carriage of tankers. The demand for tanker freight is a derived demand from oil. Therefore, one would expect that the oil price has a positive impact on shipping stock returns. We use the change in the price of Brent Crude Oil (dOIL).

Table 2 presents the summary statistics for the independent variables. The mean excess return on the world market equity portfolio is 0.2% per month. Surprisingly, the mean of the change in industrial production in China is lower than the change in the G-7 countries, while the standard deviation is higher in China. The changes in the G-7 interest rate indicate that we estimate in an environment of declining interest rates. The rise in the oil price during the sample period leads to high mean return in oil, accompanied by a high standard deviation. The extraordinary rise in the TED spread in the last months of 2007 leads to a high mean and a high standard deviation of this variable.

The correlation structure of the independent variables is shown at the bottom of Table 2. The highest correlation (0.48) is between G-7inflation and oil price changes. Overall, given that the other correlation coefficients are rather low, there should be no problem that arises from multicollinearity.

Table 2: Summary statistics of independent variables

Variable	Obs	Mean	Std. dev.	Min	Max
dWrldE	107	0.0020	0.0386	-0.1015	0.0965
dCurB	107	-0.0024	0.0188	-0.0500	0.0451
dOil	107	0.0199	0.1112	-0.3274	0.3320
dIPG7	107	0.0013	0.0045	-0.0130	0.0108
dIPChina	107	0.0005	0.0391	-0.1439	0.1512
InflG7	107	0.0019	0.0046	-0.0133	0.0130
dTED	107	0.0131	0.4066	-0.8650	1.1939
d3MIG7	107	-0.0007	0.0449	-0.2360	0.0853
d10YIG7	107	-0.0007	0.0449	-0.1005	0.1637

Correlation structure of independent variables

	dWrldE	dCurrB	dOil	dIPG7	dIPChina	InflG7	dTed	d3MIG7	d10YIG7
dCurrB	-0.3438	1.0000							
dOil	0.1259	-0.1139	1.0000						
dIPG7	0.0644	-0.0067	0.1041	1.0000					
dIPChina	-0.1002	0.0358	0.0697	-0.0608	1.0000				
InflG7	0.0370	-0.0666	0.4868	0.1588	0.0232	1.0000			
dTed	-0.0836	0.0539	-0.0921	0.0612	0.1356	0.0563	1.0000		
d3MIG7	0.1655	-0.0260	0.1310	0.3491	-0.0134	0.2352	-0.2577	1.0000	
d10YIG7	0.2187	0.2829	0.0075	0.0761	-0.1579	0.0358	-0.0477	0.2418	1.0000

4. EMPIRICAL RESULTS

4.1. One-factor regressions

Given that company-specific risk may be diversified through portfolio formation, one should consider market or systematic risks (captured by the market beta), rather than total risk (standard deviation) as the appropriate metric of risk. Tables 3 shows the results of market model regressions, hence, of the model in (1) with the world stock market factor as the single source of risk. The estimated betas of the shipping industry are around 1, implying that none of them is distinguishable from unity in a statistical sense.[7] The coefficients for the subsectors of the shipping industry are also not distinguishable among each other. Compared to other studies, such as Kavussanos and Marcoulis (2000) as well as Kavussanos et al. (2003), we document slightly higher betas. Nevertheless, betas around 1 are surprising for the highly cyclical shipping sector that additionally exhibits high operating and high financial leverage (Stopford, 2009). In fact, one would expect a beta greater than one for an industry with these risk characteristics.

Table 3: Results of one factor regressions

	dWrldE	Constant	R^2
Container	1.004***	0.022***	0.30
	(0.150)	(0.006)	
Tanker	0.966***	0.029***	0.32
	(0.140)	(0.005)	
Bulker	0.923***	0.045***	0.16
	(0.220)	(0.008)	
United States	0.982***	-0.002*	0.91
	(0.030)	(0.001)	
United Kingdom	0.881***	0.001	0.75
	(0.049)	(0.002)	
Japan	0.827***	0.000	0.37
	(0.100)	(0.004)	
Germany	1.441***	0.002	0.73
	(0.085)	(0.003)	
Standard errors in parentheses			
*** p<0.01, ** p<0.05, * p<0.1			
χ^2 test on equality of betas.		188.83	
		0.000	
χ^2 test on equality of shipping betas		0.22	
		0.895	

	dWrldE	Constant	R^2
Energy	0.832***	0.010**	0.36
	(0.110)	(0.004)	
Materials	1.068***	0.010***	0.59
	(0.086)	(0.003)	
Industrials	0.969***	0.003*	0.82
	(0.043)	(0.002)	
Consumer Discretionary	1.147***	-0.001	0.87
	(0.043)	(0.002)	
Consumer Staples	0.353***	0.002	0.20
	(0.068)	(0.002)	
Health Care	0.334***	-0.000	0.15
	(0.077)	(0.003)	
Financials	0.941***	0.002	0.74
	(0.054)	(0.002)	
Information Technology	1.909***	-0.004	0.72
	(0.120)	(0.005)	
Telecommunication Services	1.171***	-0.003	0.58
	(0.096)	(0.003)	
Utilities	0.498***	0.005	0.29
	(0.075)	(0.003)	

Compared to the country indices, the estimated shipping betas are similar to the United States (0.982). They are higher than the betas of the United Kingdom (0.881) and Japan (0.827), but lower than the beta of Germany (1.441). Moreover, the shipping betas are in the middle of the 10 sector betas. The water transportation sector is part of the industrials sector (with a beta of 0.969). As one would expect, the two betas are almost similar. The information technology sector has the highest estimated beta (1.909). All beta coefficients in Table 3 are significant at the 1% level. We test all 16 estimated betas on equality using a Wald-test. The null hypotheses of equality can also be rejected at the 1% level.

The constant terms (intercept) in the regressions of the shipping sector are all positive and strongly significant. This indicates that the shipping sector is systematically underpriced.

[7] We use a Wald-test to test the null hypothesis that the coefficients on the shipping stocks are equal to one. In all three cases, the null hypothesis of equality to one cannot be rejected.

This result was also reported by Kavussanos et al. (2003). One explanation for mispricing is high asymmetric information in the market; investors do not have access to the information that is required to price the stocks correctly. Low liquidity of the small-cap shipping stocks could be another explanation.

The R^2s of the regressions fall into the range between 0.16 and 0.32. This is low compared to the market model regressions involving country and sector indices, but still relatively high compared to previous studies. For example Kavussanos et al. (2003) document R^2s in the range from 0.02 to 0.35 for different subsectors of the water transportation industry in a previous sample period. These results indicate that the systematic part of risk in the shipping sector has increased. Shipping stocks seem to have a low portion of systematic risk that can be explained by the single beta model. Consequently, there is a large fraction of unsystematic risk that cannot be explained by a single market factor. Motivated by this observation, we analyze a multifactor model in the next section.

4.2 Multifactor model

In this section, we use a multifactor model to estimate the relationship between stock returns and the set of risk factors described in section 2. The results are shown in Table 4. A first observation is that the market betas are smaller than in the market model; they fall into the range between 0.8 (for bulkers) and 0.87 (for tankers) and are all significant at the 1%-level. These figures are more in line with the beta estimates in Kavussanos and Marcoulis (2000). Given the high cyclicality of the shipping sector coupled with high operating and high financial leverage, these results are clearly surprising. The market betas of the shipping sector are also lower than those of the country indices (except Japan). Using a χ^2-test, we reject the null hypotheses that all stock market betas are equal to zero and that the betas are equal among each other. However, the null hypothesis of equality of the stock market betas across the three shipping subsectors cannot be rejected.

Table 4: Multifactor model

	dWrldE	dCurB	dIPG7	dipchina	d3MIG7	d10YIG7	dTED	InflG7	doil	Constant	R^2
Container	0.851***	-0.720**	2.238*	0.054	-0.123	0.050	-0.021	-0.801	0.095*	0.017***	0.38
	(0.160)	(0.340)	(1.320)	(0.140)	(0.140)	(0.140)	(0.014)	(1.410)	(0.057)	(0.0061)	
Tanker	0.872***	-0.597*	-0.505	0.093	0.101	0.028	0.004	0.697	0.070	0.026***	0.38
	(0.150)	(0.320)	(1.270)	(0.140)	(0.140)	(0.130)	(0.014)	(1.360)	(0.055)	(0.0059)	
Bulker	0.796***	-1.223**	1.340	0.070	-0.014	-0.142	0.012	0.393	0.078	0.039***	0.25
	(0.240)	(0.490)	(1.930)	(0.210)	(0.210)	(0.200)	(0.021)	(2.060)	(0.084)	(0.0089)	
United States	1.060***	0.368***	0.065	-0.004	-0.025	-0.041*	0.000	-0.671***	-0.000	-0.000	0.94
	(0.027)	(0.056)	(0.220)	(0.024)	(0.024)	(0.023)	(0.002)	(0.240)	(0.010)	(0.0010)	
United Kingdom	0.827***	-0.329***	-1.460***	-0.003	0.102**	-0.026	-0.005	0.634	-0.030*	0.002	0.82
	(0.048)	(0.100)	(0.390)	(0.043)	(0.043)	(0.042)	(0.004)	(0.420)	(0.017)	(0.0018)	
Japan	0.735***	-0.375*	2.563***	-0.076	-0.111	0.015	0.004	1.360	0.056	-0.008*	0.48
	(0.110)	(0.230)	(0.890)	(0.097)	(0.096)	(0.094)	(0.010)	(0.950)	(0.038)	(0.0041)	
Germany	1.351***	-0.415**	-0.017	0.120	0.008	0.207***	-0.002	0.304	-0.066**	0.002	0.76
	(0.091)	(0.190)	(0.750)	(0.082)	(0.081)	(0.079)	(0.008)	(0.800)	(0.032)	(0.0035)	
χ^2 test on equality of betas	37.19	46.67	24.42	2.84	9.11	10.44	6.35	9.47	7.99		
	0.000	0.000	0.000	0.829	0.168	0.108	0.385	0.149	0.239		
χ^2 test on zero betas	13720.97	54.83	25.92	3.21	10.4	10.62	6.88	10.28	13.9		
	0.000	0.000	0.001	0.865	0.167	0.156	0.442	0.173	0.053		

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The coefficient on the trade-weighted value of the dollar (dCurB) is statically significant in all three shipping subsectors. The negative sign indicates that a stronger dollar has a negative effect on the returns of the shipping sector. An explanation could be that most shipping related contracts are denominated in US-$. A stronger dollar implies higher operating costs for non-US shipping firms and a lower income in the home currency (Stopford, 2009).

The coefficient on industrial production in the G-7 countries (dIPG7) is only marginally significant in the container subsector. The coefficient implies that a 1% increase in industrial production leads to a 2.2% increase in monthly returns in the container sector. Only the Japanese equity market benefits even stronger from an increase in G-7 industrial production. The negative sign on industrial production in the tanker sector is surprising. One would expect that with rising output the demand for oil increases as well. Against the public expectation, the industrial production in China also does not enter significantly in any subsector of the shipping industry. Moreover, the term structure of interest rates, the TED spread, and the inflation rate do not have a significant impact on the returns on shipping stocks.

The change in the oil price enters significantly in the container equation, but it shows no significance in the other shipping subsectors. The direction of influence tends to be positive: a higher oil price leads to an increase in the returns on shipping stocks. Given that oil is one of the main input factors in the production of water transportation services, one would expect a negative influence. However, oil is also a proxy for the state of the world economy and, hence, may exert a positive influence.

In results not reported here, we tried several alternative explanatory variables to check our results for robustness. An exclusion of the MSCI World Equity Index does not qualitatively change our estimations. We tried to include a direct measure of international trade, such as the IMF export index, but it did not enter significantly into the regression. One would further assume that measures of stock market volatility (e.g., the VIX index) and a down-market dummy variable to account for asymmetric perception of risk have explanatory power. However, both of them turn out not to be significant. Finally, we substituted the change in the oil price with the change in the Dow Jones Commodity Spot Index. The corresponding coefficient was insignificant and the regression R^2 was slightly lower.

For the intercept terms (alphas) we get the same results in the multifactor model in table 4 than in the one-factor model in table 3. Most important, the estimated alphas on shipping stocks are significant at the 1% level. We again conclude that the shipping sector tends to be underpriced in a securities market line framework. However, the alphas are smaller in the multifactor model than in the market model. Part of the alpha is captured by the additional factors apart from the market factor. This notion is further strengthened by the observation that the R^2 is notably higher compared to the single-factor case. On average, the inclusion of macroeconomic factors increases the fraction of explained variance in the multifactor model by 7% percentage points.

Finally, we conduct two kinds of χ^2-tests. First, we test the null hypothesis that all beta coefficients are equal across all asset classes for a given factor. We reject this hypothesis for the estimated coefficients on the world market index, the currency basket against the US-$, and industrial production. Second, we test the null hypothesis that all beta coefficients are simultaneously equal to zero for a given factor. This null hypothesis is rejected for the estimated coefficients on the world market index, the currency basket on industrial production, and the oil price. From these results we hypothesize that the latter four factors are not only drivers of stock return volatility, but that they also have the potential to be sources of systematic risk. In this case, exposure to these risk factors should be rewarded with a risk premium. To validate this notion, it is necessary to include a pricing restriction into the model. Therefore, in the final section we test a fully-fledged asset pricing model by exploiting the moment conditions imposed by full information processing.

4.3 Global economic risk factors

In our asset pricing model, we use those risk factors for which the null hypothesis that all coefficients are simultaneously equal to zero can rejected using the χ^2-test. Specifically, our four risk factors are: the world market index, the trade-weighted value of the US-$ dollar, G7 industrial production, and the oil price. In two different models we use country indices and sector indices as spanning assets. The results from estimating the model in (3) using GMM are shown in table 5 and table 6.

In a first step, we use the world market index as the only risk factor. In table 5, the market beta is between 0.67 for bulker and 0.96 for container. This reinforces our findings from section 4.2 that the risk of shipping stocks is lower than the risk of the overall stock market. The country betas are also similar to those from the multifactor model. The estimated risk premium is 0.01% per month, which is much smaller than the historical excess return of 0.20% per month as reported in table 2. One explanation for this result is that the U.S. stock market earned a negative mean return during the sample period, coupled with a relatively low standard deviation. Given that the GMM estimator puts a heavy weight on the asset with the lowest standard deviation (Cochrane (2005)), the world market risk premium will presumably be underestimated. Given this very low estimate for the world market risk premium, one expects that the one-factor model is not powerful in explaining the cross-section of expected stock returns. As indicated by the χ^2-test of over-identification (the test for the goodness of fit), the model systematically violates the moment conditions that capture the cross-sectional pricing restrictions. Given that the test of over-identification is not very powerful in detecting misspecifications (Hamilton (1994)), this rejection of the null hypothesis (i.e., the pricing conditions) is surprising. However, this result is also justified on the basis of the average pricing error of the model reported in Table 5, which does not differ significantly from the average ex post return. Overall, we conclude that the world market factor alone is not able to price all assets in the system of equations with sufficient accuracy.

The four-factor model with the additional risk factors generates lower market betas for the shipping subsector, while the country betas remain virtually unchanged. The market risk premium is now 0.52%, which is much higher than the market excess return during our sample period, but similar to the figures reported in the previous literature (Mehra and Prescott (1985), Dimson et al. (2007)). The currency risk premium on the US-$ is negative with -1.2% per annum. However, all beta coefficients apart from the U.S. load with a negative sign on this factor, implying a positive total return contribution. The U.S. market itself loads negatively on currency risk, hence, a stronger US-$ implies a lower return on U.S. firms. Intuitively, a stronger US-$ weakens exports and strengthens imports, which has an adverse impact on cash flows from U.S. firm.

With respect to industrial production, we find notable differences. The strongest impact of this factor is on the container sector, while the impact on the other shipping subsectors is smaller albeit still positive. In contrast, industrial production has a negative impact on three of the four country indices. In this respect, shipping stocks therefore differ fundamentally from country indices, because they profit from increasing production in the G-7 countries. Note, however, that the risk premium is a negative -1.3% during our sample period, which implies that the total return attribution for shipping stocks from industrial production risk is negative. There are similar differences with respect to changes in oil price, also suggesting that shipping stocks are different in their risk characteristics from stocks overall. As before, the change in the oil price has a positive influence on the shipping stocks. In contrast, all country indices (except Japan) exhibit negative exposures against oil price changes. Taking over one unit of risk related to changes in the oil price earns a huge risk premium of 37.6% during our sample period.

Most important from an asset pricing perspective, the average pricing error of this four-factor model is much lower than that of the one-factor model (<0.001 vs. 0.015). Obviously, the multifactor model is better able to explain the cross-section of expected stock returns. This notion is also justified by looking at the χ^2-test of over-identification (the test for the goodness of fit). In fact, the moment conditions cannot be rejected, indicating that the model no longer systematically violates the pricing conditions. Overall we therefore conclude that a multidimensional definition of systematic risk is necessary to correctly price shipping stocks when country indices are used as spanning assets. The four risk factors in Table 5 seem to be systematic sources of risk, and the risk profiles of shipping stocks differ from those of country indices.

Table 5: Long-run risk with country indices

	One-factor model			Four-factor model				
	dWrlmE beta	Average return %per month	Average pricing error %	dWrlmE beta	dCurrBe beta	dIPG7 beta	doil beta	Average pricing error %
Container	0.9659	0.0217	0.0234	0.8135	-0.7627	1.5723	0.0752	0.0010
	(0.129)		(0.008)	(0.104)	(0.229)	(0.648)	(0.023)	(0.008)
Tanker	0.8641	0.0289	0.0303	0.8534	-0.5363	0.3734	0.0624	-0.0005
	(0.119)		(0.008)	(0.054)	(0.163)	(0.715)	(0.023)	(0.007)
Bulker	0.6794	0.0430	0.0483	0.6159	-1.3627	0.5460	0.0898	-0.0015
	(0.195)		(0.012)	(0.134)	(0.291)	(0.943)	(0.029)	(0.010)
United States	0.8749	-0.0003	-0.0009	1.0357	0.3186	-0.1865	-0.0125	-0.0001
	(0.032)		(0.001)	(0.016)	(0.034)	(0.158)	(0.006)	(0.001)
United Kingdom	0.8456	0.0024	0.0023	0.8556	-0.2733	-0.5796	-0.0331	-0.0002
	(0.038)		(0.002)	(0.021)	(0.072)	(0.211)	(0.012)	(0.002)
Japan	0.8909	0.0011	0.0014	0.7313	-0.3852	2.2525	0.0552	0.0015
	(0.081)		(0.005)	(0.062)	(0.165)	(0.587)	(0.023)	(0.004)
Germany	1.3778	0.0037	0.0042	1.4092	-0.2470	-0.1373	-0.0233	0.0004
	(0.080)		(0.003)	(0.071)	(0.098)	(0.340)	(0.015)	(0.003)
Mean pricing error			0.0156					0.0001
	dWrlmE		χ^2test on over identification	dWrlmE	dCurrB	dIPG7	dOil	χ^2test on over identification
Risk premium	0.0001		37.39	0.00521	-0.01156	-0.01306	0.37587	12.85
	(0.0004)		0.0004	(0.002)	(0.010)	(0.010)	(0.219)	0.9983

To check the robustness of our results, we estimate the model using sector indices as the spanning assets. If the model in (3) is a universally valid asset pricing model, the estimated risk premiums should be independent on the choice of the set of test assets. The results are shown in Table 6. The estimated risk premiums on the world market index and on the currency basket are of similar magnitude as in Table 5, while the risk premium on industrial production is now positive. The risk premium on oil decreases substantially, but it is still positive. Overall, we observe lower standard errors and conclude that the model with sector indices as spanning assets is better in explaining the global risk-return structure. One explanation for the differences between Tables 5 and 6 may be that we estimate a relatively short time period with peculiar risk-return characteristics. However, similar to using country indices as spanning assets, the moment conditions of the one-factor model are rejected based on the χ^2-test of over-identification. In contrast, the four-factor model is able to capture the cross-sectional pricing restrictions.

Looking at shipping stocks, the market betas remain quite stable and well below 1. Therefore, shipping stocks exhibit low covariance risk. The sensitivities on the currency basket and the oil price remain negative and positive, respectively, while shipping stocks now load positively on industrial production. Most important, the risk profile of shipping stocks seems to be specific, as none of the other 10 sector indices exhibit the same factor loadings on the four risk factors. Even the industrial sector, of which water transportation is a part of, has a different risk-return profile and loads positive on the currency basket. This supports the notion that ships have the potential to serve as a unique and distinguishable asset class.

Table 6: Long run risk with sector indices

	One factor model				Four factor model				
	dWrldE beta	Average return % per month	Average pricing error %		dWrldE beta	dCurrB beta	dIPG7 beta	dOil beta	Average pricing error %
Container	0.9154	0.0216	0.0206		0.8856	-0.4990	1.0201	0.0738	-0.0022
	(0.121)		(0.008)		(0.252)	(0.430)	(1.567)	(0.056)	(0.002)
Tanker	0.9924	0.0289	0.0273		0.8180	-0.7033	0.2275	0.0903	0.0018
	(0.093)		(0.007)		(0.226)	(0.375)	(1.713)	(0.068)	(0.002)
Bulker	0.8904	0.0430	0.0429		0.6817	-1.3043	0.9821	0.0817	0.0003
	(0.160)		(0.011)		(0.323)	(0.578)	(1.984)	(0.072)	(0.001)
Energy	0.9820	0.0101	0.0096		0.7502	-0.2269	-1.5983	0.1526	-0.0007
	(0.076)		(0.004)		(0.144)	(0.177)	(1.049)	(0.066)	(0.001)
Materials	1.1190	0.0108	0.0096		0.9977	-0.3775	-1.0162	0.0299	0.0008
	(0.060)		(0.004)		(0.132)	(0.219)	(1.156)	(0.056)	(0.002)
Industrials	0.9374	0.0048	0.0035		0.9659	0.0327	0.4487	0.0052	0.0006
	(0.032)		(0.001)		(0.091)	(0.160)	(0.480)	(0.022)	(0.002)
Consumer Discretionary	1.1241	0.0008	-0.0011		1.1850	0.2280	0.3550	0.0017	0.0010
	(0.030)		(0.002)		(0.091)	(0.162)	(0.488)	(0.026)	(0.002)
Consumer Staples	0.4993	0.0026	0.0023		0.3285	-0.2922	-0.2909	-0.0463	-0.0011
	(0.058)		(0.003)		(0.121)	(0.130)	(0.847)	(0.037)	(0.002)
Health Care	0.4038	0.0002	-0.0002		0.3475	-0.0595	0.3251	-0.0718	0.0012
	(0.057)		(0.003)		(0.138)	(0.212)	(0.616)	(0.037)	(0.002)
Financials	0.9676	0.0036	0.0024		0.9425	-0.1304	0.1075	-0.0539	0.0007
	(0.042)		(0.002)		(0.100)	(0.112)	(0.536)	(0.035)	(0.001)
Information Technology	1.5212	-0.0022	-0.0056		1.9957	0.6236	-0.0068	0.0913	0.0000
	(0.109)		(0.005)		(0.231)	(0.263)	(1.180)	(0.069)	(0.002)
Telecommunication Services	1.0405	-0.0011	-0.0033		1.1983	0.0937	0.5024	-0.0545	-0.0016
	(0.063)		(0.004)		(0.171)	(0.238)	(1.041)	(0.072)	(0.003)
Utilities	0.7091	0.0054	0.0048		0.4516	-0.4185	-0.6528	-0.0357	-0.0011
	(0.076)		(0.003)		(0.160)	(0.172)	(0.867)	(0.049)	(0.001)
Mean pricing error			0.0087						-0.00002
	dWrldE		χ^2test on over identification		dWrldE	dCurrB	dIPG7	dOil	χ^2test on over identification
Risk premium	0.0014		60.69		0.0031	-0.0249	0.0040	0.0658	19.25
	(0.0003)		0.0001		(0.001)	(0.014)	(0.006)	(0.054)	0.9999

5. Conclusions

This study investigates the common risk factors for the shipping industry and its subsectors container, tanker, and bulker shipping. Our empirical findings suggest that the shipping sector exhibits lower risk in terms of beta than the overall stock market. In the period under investigation, we document similar patterns as in previous studies that investigate the risk of the shipping sector: a beta lower than one and a high portion of unsystematic risk. The results from our asset pricing tests indicate that market risk alone is not sufficient to price an equity universe that includes shipping stocks. One implication is that the decision to invest in the shipping sector cannot be made from looking at the market beta alone. Instead, risk is multi-dimensional and other risk factors must also be taken in consideration. As long-run systematic risk factors that drive expected stock returns we identify the equity market risk, the currency risk against the US-$, the industrial production risk, and the risk of changing oil prices. These global factors have a significant contribution in explaining the return differential across asset classes. The remaining pricing error is so small that a GMM test for the goodness of fit cannot reject the cross-sectional pricing conditions.

Moreover, the different global risk profile of the shipping sector compared to country and other industry indices suggests that the shipping sector should be regarded as a separate asset class. The specific risk-return profile of the shipping sector is of utmost importance for investors whose goal is to achieve maximal diversification. While a look on the market factor alone indicates a nearly average risk profile, the exposures against the other risk factors suggest that an investor who is already invested in country or other sector indices could further enhance his risk-return spectrum by investing in the shipping sector.

Finally, the factor sensitivities also have important implications for estimating the cost of capital in the shipping sector. In practice, the cost of capital is often based on simple heuristics. Having estimated the exposures of different subsectors of the shipping industry on the economic risk factors and the associated risk premiums, it is straightforward to calculate the cost of equity capital.

Appendix A

List of shipping stocks used in the study.

Container	Time period
Alexander & Baldwin	01/1999 - 12/2007
AP Moeller Maersk A	01/1999 - 12/2007
AP Moeller Maersk B	01/1999 - 12/2007
China Shipping Container Lines (CSCL)	06/2004 - 12/2007
Compania Sud Americana De Vapores S.A. (CSAV)	01/1999 - 12/2007
Evergreen Marine	01/1999 - 12/2007
Finnlines	01/1999 - 12/2007
Hanjin Shipping Co. Ltd.	01/1999 - 12/2007
Heung-A Shipping Co. Ltd.	01/1999 - 12/2007
Hyundai Merchant Marine Co. Ltd.	01/1999 - 12/2007
Kawasaki Kisen (K-Line)	01/1999 - 12/2007
MISC Berhad	01/1999 - 12/2007
Mitsui OSK Lines (MOL)	01/1999 - 12/2007
Neptune Orient Lines (NOL)	01/1999 - 12/2007
Nippon Yusen Kabushiki Kaisha (NYK)	01/1999 - 12/2007
Orient Overseas Intl.	01/1999 - 12/2007
Regional Container Line (RCL)	01/1999 - 12/2007
Samudera Shipping Line	01/1999 - 12/2007
Sinotrans Ltd.	02/2003 - 12/2007
Trailer Bridge Inc.	01/1999 - 12/2007
Wan Hai Lines	01/1999 - 12/2007
Wilh. Wilhelmsen ASA	01/1999 - 12/2007
Yang Ming Marine Transport Corp.	01/1999 - 12/2007

Tanker	Time period
Brostrom	01/1999 - 12/2007
Concordia Maritime	01/1999 - 12/2007
Dampskibsselskabet "NORDEN" A/S (D/S Norden)	01/1999 - 12/2007
Dampskibsselskabet "Torm" A/S (D/S Torm)	01/1999 - 12/2007
Euronav	12/2004 - 12/2007
Frontline Ltd.	01/1999 - 12/2007
Great Eastern Shipping	01/1999 - 12/2007
I.M. Skaugen ASA	01/1999 - 12/2007
James Fisher & Sons	01/1999 - 12/2007
Jinhui Shipping & Transportation Ltd.	01/1999 - 12/2007
Knightsbridge Tankers Ltd.	01/1999 - 12/2007
Mitsui OSK Lines (MOL)	01/1999 - 12/2007
Neptune Orient Lines (NOL)	01/1999 - 12/2007
Nordic American Tanker Shipping	01/1999 - 12/2007
Odfjell "A"	01/1999 - 12/2007
Overseas Shipholding Group (OSG)	01/1999 - 12/2007
Shinwa Kaiun	01/1999 - 12/2007
Ship Finance Intl.	06/2004 - 12/2007
Stolt Nielsen	01/1999 - 12/2007
Teekay Corporation	01/1999 - 12/2007
Tsakos Energy Navigation	03/2002 - 12/2007

Bulker	Time period
Cosco Corp.	01/1999 - 12/2007
Dampskibsselskabet "NORDEN" A/S (D/S Norden)	01/1999 - 12/2007
Dampskibsselskabet "Torm" A/S (D/S Torm)	01/1999 - 12/2007
Excel Maritime Carriers	08/2000 - 12/2007
Golden Ocean Group	12/2004 - 12/2007
Great Eastern Shipping	01/1999 - 12/2007
Mitsui OSK Lines (MOL)	01/1999 - 12/2007
Pacific Basin Shipping	06/2004 - 12/2007
Percious Shipping	01/1999 - 12/2007
U-Ming Marine Transport	01/1999 - 12/2007

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