# Information Flows in the Global Shipping Industry: A Cointegration Approach

Joshua Shackman[a,*], Paul Lambert[a], Eyasu Aregawie[a], Phoenix Benitez[a], David Henderson[a]

[a] California State University Maritime Academy, 200 Maritime Academy Dr, Vallejo, CA 94590, USA

[*]Corresponding author. E-mail: Jshackman@csum.edu

**Keywords**: Maritime stocks, transparency, cointegration, gradual information diffusion

**Abstract**: *In this study we examine how global maritime stock prices impact the stock prices of large transportation companies in the U.S. and other large markets. Maritime stocks are chosen because they are central in global trade and may be good indicator of future global stock market and economic trends. Maritime companies are often owned by families or governments, and are traded in stock markets with lower standards of accountability. We use cointegration and vector error-correction analysis to analyze the short-term and long-term relationship among our chosen stocks. We find evidence of a gradual diffusion of information from maritime stock prices to large U.S.-based transportation companies.*

## INTRODUCTION

Few industries are more central to international trade than the maritime sector, with 80% of world trade by volume and 70% by value being carried by ships. The maritime industry is also unique in that in spite of its large size, leadership in this sector often comes from smaller countries such as Greece, Singapore, Norway, and South Korea with shipping the U.S. and U.K. playing a surprisingly modest role. In addition, ownership of even the largest companies tends to be concentrated in the hands of a single family. But in spite of the central importance of the maritime industry and its unique global ownership structure, very little research has been done on maritime stocks.

Giannakopoulou, et al. (2016) point out that in spite of the large size of the maritime sector, family ownership is common in many countries that have large shipping industries. For example, Denmark's AP Moller-Maersk in spite of being the world's largest shipping company has over 50% of its voting shares controlled by a holding company owned solely by the founding family. The Mediterranean Shipping Company and CMA CGM Group are the second and third largest shipping companies in the world respectively, but both are majority owned and operated by the founding families. None of the top twenty shipping companies are traded on U.S. stock exchanges, perhaps because foreign stock exchanges can be more conducive to family controlled companies.

Even those shipping companies listed on American stock exchanges are often controlled by the founding family. Syriopoulos and Tsatsaronis (2011) find that Greek shipping firms listed in U.S. stock markets follow a model of corporate governance similar to maritime companies listed on non-U.S. stock exchanges. 80% of these Greek shipping firms were found to have a CEO from the founding family, and on average the board of directors controlled 28% of the shares.

The fact that many of the leading maritime shipping companies are family-owned and headquartered in dispersed countries has several implications for how their stock prices may behave. First of all, family-ownership and control may lead to information being closely held and not widely released to the public.

This may slow information available to stock traders and slow information flows. Secondly, the maritime shipping companies compete for the same customers around the world in a global market so their fates are tightly intertwined. However, their shares are traded on different exchanges around the world (many of which don't have higher standards for transparency) so stock price adjustments may be slow.

In this study, we will be looking at the long-term relationship between global shipping company stock prices and the stock prices of some large truck and rail transport companies. We expect maritime stock prices to reflect information relevant for other transportation companies involved in the same supply chain. But due to corporate governance and transparency issues in the maritime industry, we expect that stock price adjustments in other portions of the transportation sector may be slow. We will use unit root and cointegration to test for short-term and long-term relationships between maritime, trucking, and rail stocks.

## Literature Review

Prior research on maritime shipping stocks has been limited, and has focused on general risk and return attributes of shipping stocks. Merikas, at al. (2009) and Merikas et al. (2010) look at shipping stock IPOs and find evidence of significant opening day underpricing and longer-term underperformance. Kavussanos, et al. (2003) and Drobetz, et al. (2010) find that shipping stocks are overall low risk with low betas. Drobetz, et al. (2010) finds that shipping sector betas are driven heavily by industry-specific factors such as freight rate volatility and financing risk. Evidence of the unique nature of shipping stocks was found by Grelck, et al. (2009) who found that adding shipping stocks has diversification benefits and can lead a higher Sharpe ratio.

Interest in the maritime industry's impact on the stock market has focused heavily on the Baltic Dry Index (BDI), which is a measure of freight rates in the global dry bulk shipping sector. Erdogan, et al. (2013) find bidirectional causality between the BDI and the Dow Jones Industrial Average. Bakshi (2011) find that the BDI not only predicts global stock prices but also commodity prices and economic activity. They find informational spillovers to be time-varying and dependent on market conditions. Alizadeh and Muradoglu (2014) find that the BDI can be used to predict U.S. stock prices, which they attribute to gradual information diffusion. Other evidence of gradual diffusion comes from Xiao (2012) who finds that the BDI has a fast impact on Chinese shipping stocks but a slower impact on port and shipbuilding stocks.

Just as the BDI can be a vital indicator of the global economy or global stock markets, it may be the case that maritime stocks transmit vital information useful for stock market investors around the world. Just as Alizadeh and Muradoglu (2014) and Xiao (2012) find a gradual diffusion of information from the BDI , other studies have demonstrated the gradual diffusion of information from stock market returns. Rapach, et al.(2013) find evidence of gradual information diffusion by demonstrating that U.S. stock market returns can predict future returns in other stock markets around the world. They attribute their result in part to the possibility of stock market traders focusing on the U.S. exchanges before giving attention to other global markets. Similarly, Lin (2015) finds that stock returns in many Asian markets can be predicted by Singapore stock market returns.

While it is logical that maritime stock prices information of importance to global stock markets, this information may diffuse quite slowly. Chan and Hameed (2006) argue that family ownership or poor corporate governance may also slow down information flows from stocks. Lagoarde-Segot and Lucey (2008) find that poor corporate governance is associated with market inefficiency in emerging markets,

which should also lead to slower information flows. Thus we should expect lagged rather than current period maritime stock prices to exert their influence on other stock prices around the world.

## Data

Monthly stock price data was collected on the ten largest publicly traded marine transportation companies in the world based on the twenty-foot equivalent unit (TEU) capacity of their fleet. All but two of these companies are from Asia, with AP Moeller-Maersk headquartered in Denmark and Hapag-Lloyd headquartered in Germany. None are listed on U.S. stock exchanges. Data was collected up to January, 2018 with no company going back further than 20 years

To test the information flows from these maritime companies, collected monthly stock price data from the largest publicly traded trucking and rail companies. These include Union Pacific (UNP), which is a U.S. based rail company and JB Hunt (JBHT), which is based on the U.S. While many of the other large rail and trucking companies are privately held, we also found data on the second largest rail and trucking companies. We collected data on Canadian National Railway (CNI) and DSV A/S (DSV), the latter of which is largest Danish trucking and logistics company. Finally, we include monthly data on the BDI.

Table 1: Companies or Indices Used in This Study

| Company or Index | Country | Sector | Abbreviation |
|---|---|---|---|
| A.P. Moller–Maersk Group | Denmark | Maritime Freight | MAERSK |
| Evergreen Marine Corporation | Taiwan | Maritime Freight | EVERGREEN |
| Hapag-Lloyd AG | Germany | Maritime Freight | HLAG |
| Mitsui O.S.K. Lines | Japan | Maritime Freight | MITSUI |
| Nippon Yusen Kabushiki Kaisha | Japan | Maritime Freight | NYKA |
| Yang Ming Marine Transport Corporation | Taiwan | Maritime Freight | YANGMING |
| China Ocean Shipping Company | China | Maritime Freight | COSCO |
| Wan Hai Lines Ltd. | Taiwan | Maritime Freight | WANHAI |
| Hyundai Merchant Marine | South Korea | Maritime Freight | HYUNDAI |
| Kawasaki Kisen Kaisha, Ltd. | Japan | Maritime Freight | K-LINE |
| Union Pacific Railroad | U.S. | Rail Freight | UNP |
| Canadian National Railway | Canada | Rail Freight | CNI |
| J.B. Hunt Transport Services, Inc | U.S. | Trucking | JBHT |
| DSV A/S | Denmark | Trucking | DSV |
| Baltic Dry Index | U.K. | Freight Rate Index | BDI |

## Methodology

As a first step in our analysis of the long-term and short-term relationships between our chosen stocks, we check for stationarity in all of our series. The test we use is the Phillips and Perron (1988) test. This is a widely used test for stationarity and it controls for serial correlation through non-parametric methods. To test for cointegration, we use the Johansen (1995) test. This test is widely used, including in related studies to this one such as Ergodan, et al. (2013), Alizadeh, A. H., & Nomikos, N. K. (2007) Jamaani, F., & Roca, E. (2015). and Bildirici, et al. (2015)

We chose to include a linear trend in the cointegrating equation (levels) since all of the rail and trucking stocks in our sample had a clear upward linear trend and most of the maritime stocks had a linear trend as well. The general form of the vector error correction model in this case is (Harris,1995;StataCorp,2017):

$$\Delta Y_t = \alpha(\beta Y_t + \mu + \rho t) + \sum_{i=1}^{p-1} \Gamma_i \, \Delta Y_{t-1} + \gamma + \tau t + \epsilon_t$$

The key parameters in this case are α, which denotes the error-correction process as to how each of the stocks adjusts back to the long-term equilibrium. Γ refers to the short-term reactions of each stock price to changes in the other stock prices. We will use these parameters to assess the long-term and short-term inter-relationships between maritime stocks, trucking stocks, rail stocks, and the BDI. Lag lengths are chosen through the Schwartz-Bayesian Information Criteria (SBIC).

Our cointegration equations will be carried out as follows. For each maritime stock, we will examine its cointegrating relationship with UNP, JBHT, and BDI. Including UNP and JBHT in the equations will allow us to test information flow from the maritime sector (all traded on exchanges outside the U.S.) to two large non-maritime transportation stocks traded on U.S. exchanges. Since UNP and BDI are the U.S.-based companies, we will run a second set of cointegration tests with each maritime stock and CNI, DSV, and BDI. Since CNI and DSV and not U.S.-based firm, this will serve as a robustness test.

## Results

Results from the Phillips-Perron unit root test can be shown in Table 2 below. For all stock prices levels (in logs) the test statistic is not significant at the 5% level. Hence we cannot reject the null hypothesis of a unit root and non-stationarity. However, for first-differences the null hypothesis of a unit root was rejected at the 1% level in every case. Thus we can conclude that all of our series are integrated of order 1 and we can proceed to our cointegration tests.

Table 2: Unit Root Tests

| Variables | Levels | First-Differences |
|---|---|---|
| MAERSK | -2.18 | -14.438** |
| EVERGREEN | -2.731 | -16.721** |
| HLAG | -0.642 | -4.844** |
| MITSUI | -1.922 | -13.468** |
| NYKA | -2.203 | -8.524** |
| YANGMING | -1.722 | -13.595** |
| COSCO | -2.201 | -11.948** |
| WANHAI | -2.233 | -16.75** |
| HYUNDAI | -0.186 | -15.323** |

| | | |
|---|---|---|
| K-LINE | -1.669 | -13.199** |
| DSV | -2.787 | -33.343** |
| CNI | -0.842 | -16.192** |
| UNP | 0.222 | -17.337** |
| JBHT | 0.086 | -14.986** |
| BDI | -2.501 | -12.517** |

*Significant at the 5% level, ** Significant at the 1% level

Table 3 presents the cointegration results for each maritime stock when tested for cointegrating relationships with UNP, JBHT, and BDI. In all ten cases, the Johansen results for each maritime stock revealed the presence of one cointegrating vector. However, in the case of Yang Ming there was no significant coefficient for the error correction term for any of the four series. The only significant coefficient was positive, which indicates a lack of a conversion to the long-term equilibrium and in fact implies a divergence away from. So the result for YANGMING is disregarded.

The main pattern shown in Table 3 is that for most case UNP is the stock that responds to diverges from the long-term equilibrium and thus it is the variable that lags rather than leads in the long-term in most of these cases. In only three cases (EVERGREEN, NYKA, HYUNDAI) does the maritime stock move in response to divergence from the long-term equilibrium. In three cases JBHT has the significant error-correction term. Overall, this is evidence that information is evidence that information is flowing gradually to the large American rail and trucking companies.

Table 3: Cointegration Results with Maritime Stocks, UNP, JBHT, and BDI

| Maritime Stock | Cointegrating Vectors | Negative and Significant Error-Correction Terms |
|---|---|---|
| MAERSK | 1 | UNP*, JBHT** |
| EVERGREEN | 1 | EVERGREEN** |
| HLAG | 1 | UNP** |
| MITSUI | 1 | UNP**, JBHT |
| NYKA | 1 | NYKA**, UNP** |
| YANGMING | 1 | None |
| COSCO | 1 | UNP** |
| WANHAI | 1 | UNP* |
| HYUNDAI | 1 | HYUNDAI* |
| K-LINE | 1 | UNP*, JBHT* |

**Significant at the 1% level, Significant at the 5% level

Table 4 presents a comparison between the stocks that react to changes in te long-term equilibrium and the short-term lead-lag relationships found for the maritime stocks. This was done by looking at the significance of the coefficients on one-month lags for each of the four series. While quite a few significant relationships were found between non-maritime stocks, Table 4 only reports the lead/lag relationships that involve maritime stocks. Overall we find evidence of bi-directionality, but a trend for maritime stocks leading with five such relationships found as opposed to three relationships with maritime stocks lagging. Interestingly enough, BDI does not lead any maritime stock which is surprising considering that the BDI is

a direct measurement of sea freight costs. Perhaps since BDI is a real-time measure of freight rates rather than a stock its information is included in maritime stocks quickly so a lagged relationship is not found.

Table 4: Long-Term Short-Term Result Comparison (UNP, JBHT, and BDI regressions)

| Maritime Stock | Long-Term Lag Stocks | Maritime Short-Term Lead-Lag Relationships |
|---|---|---|
| MAERSK | UNP*, JBHT** | UNP leads Maersk* |
| EVERGREEN | EVERGREEN** | EVERGREEN leads JBHT**, JBHT leads EVERGREEN |
| HLAG | UNP** | None |
| MITSUI | UNP**, JBHT | MITSUI leads UNP**, MITSUI leads JBHT** |
| NYKA | NYKA**, UNP** | JBHT leads NYKA* |
| COSCO | UNP** | COSCO leads UNP**, COSCO leads BDI* |
| WANHAI | UNP* | None |
| HYUNDAI | HYUNDAI* | None |
| K-LINE | UNP*, JBHT* | None |

**Significant at the 1% level, Significant at the 5% level

Table 5 presents the results of the Johansen tests when CNI and DSV are substituted for UNP and JBHT. Overall the cointegration results are not as strong with CNI and DSV. For two of the cases no cointegrating vector was found. In another two cases, no negative and significant error-correction term was found indicating no convergence to equilibrium. In the remaining five cases, maritime stocks were found to have a significant convergence to the long-term equilibrium with a significant impact of the error-correction term. In four of these cases, DSV was also found to have a negative and significant coefficient for the error-correction term. In all four of these cases the maritime companies are Asian, and four of them are Taiwanese. It may be the case that diffusion of information between a European company like DSV and companies in smaller Asian countries like Taiwan and South Korea is slower than information flows between DSV and European stocks such as MAERSK and HLAG.

Table 5: Cointegration Results with Maritime Stocks, CNI, DSV, and BDI

| Maritime Stock | Cointegrating Vectors | Negative and Significant Error-Correction Terms |
|---|---|---|
| MAERSKA | 1 | None |
| EVERGREEN | 1 | EVERGREEN**, DSV** |
| HLAG | 1 | HLAG** |
| MITSUI | 1 | None |
| NYKA | 0 | N/A |
| YANGMING | 1 | YANGMING**, DSV** |
| COSCO | 0 | N/A |
| WANHAI | 1 | WANHAI**, DSV** |
| HYUNDAI | 1 | HYUNDAI**, DSV** |
| K-LINE | 1 | None |

**Significant at the 1% level, Significant at the 5% level

Table 6 presents the comparison between long-term and short-term lead lag relationship. While several lead-lag relationships were found between non-maritime stocks, only two were found with maritime stocks. In both cases, DSV leads the maritime stocks. Again, BDI is not found to have any lead relationship with the maritime stocks which again suggests that information from the BDI is quickly factored into pricing of maritime stocks.

Table 6: Long-Term Short-Term Result Comparison (CNI, JBHT, and BDI regressions)

| Maritime Stock | Long-Term Lag Stocks | Maritime Short-Term Lead-Lag Relationships |
|---|---|---|
| EVERGREEN | EVERGREEN**, DSV** | DSV leads EVERGREEN** |
| HLAG | HLAG** | None |
| YANGMING | YANGMING**, DSV** | None |
| WANHAI | WANHAI**, DSV** | DSV leads WANHAI* |
| HYUNDAI | HYUNDAI**, DSV** | None |

**Significant at the 1% level, Significant at the 5% level

## Conclusion

In this paper we find relatively strong evidence of slow but significant information flows from non-U.S. maritime stocks to large U.S. stocks like UNP and JBHT. This is shown both by long-term cointegrating relationships and short-term first-difference results. Just as Rapach, et al.(2013) found evidence of gradual diffusion of information from U.S. to other stock markets in the world, we find evidence of gradual diffusion of information from maritime companies to large U.S.-traded companies. This result is different than those by Rapach, et al. (2013) and Lin (2015) in that they find evidence of gradual information flow from more developed markets to smaller or lesser developed markets. This study on the other hand examines information flows from smaller and lesser developed stock markets to larger and better developed markets. While this study has examined individual stocks rather than market indices, the stocks we have chosen represent the largest players in the global freight transportation industry.

It is also noteworthy that gradual information diffusion is not nearly as present when examining the impact on two non-U.S. stocks. It may be that information flow are much quicker between transportation stocks for companies located outside the U.S. The main exception we find is for DS) and five maritime stocks from small Asian countries. This suggests information my be slow between geographically distant or linguistically different stocks. Two of these stocks (HYUNDAI and EVERGREEN) have heavy family ownership which might also lead to slow information diffusion.

Our results are also somewhat contradictory of prior studies on BDI and stock markets. Unlike Erdogan, et al. (2013) and Bakshi (2011), we don't find evidence that the BDI leads stock prices including maritime stock prices. More specifically, this also contradicts Xiao (2012) who finds that the BDI leads maritime and other transportation-related stocks. While Alizadeh and Muradoglu (2014) suggest that information from the BDI is diffused gradually, it may also be the case that its information is diffused quickly. Since it is an objectively calculated freight rate, information from it should be easy to process. Also, freight rates

are already a part of transportation company operations and profits so BDI information may already be factored into maritime stock prices.

An implication of this study is that maritime stock prices may be a useful predictor of stock prices around the world and global trade trends, similar to how the BDI has been used. The maritime stocks used in this study account for a large portion of world trade, but are generally from lesser developed stock markets and often have less than transparent corporate governance. This factors may slow the important information from these stocks.

A limitation of this study is that many of the world's largest freight transportation companies are privately held. This excludes important information on how valuation of the global shipping sector impacts other markets. We also only used the largest companies in this study. It may be the case that smaller maritime stocks have even slower diffusion of information. In addition to examining smaller stocks, another area for future research is to examine indices of different transportation sectors and perhaps sub-indices of transportation stocks within single countries.


Alizadeh, A. H., & Nomikos, N. K. (2007). Investment timing and trading strategies in the sale and purchase market for ships. *Transportation Research Part B: Methodological*, *41*(1), 126-143.

Alizadeh, A. H., & Muradoglu, G. (2014). Stock market efficiency and international shipping-market information. *Journal of international financial markets, institutions and money*, *33*, 445-461.

Bakshi, Gurdip S. and Panayotov, George and Skoulakis, Georgios, The Baltic Dry Index as a Predictor of Global Stock Returns, Commodity Returns, and Global Economic Activity (January 26, 2011). AFA 2012 Chicago Meetings Paper. Available at SSRN: https://ssrn.com/abstract=1787757 or http://dx.doi.org/10.2139/ssrn.1787757

Bildirici, M. E., Kayıkçı, F., & Onat, I. Ş. (2015). Baltic Dry Index as a major economic policy indicator: the relationship with economic growth. *Procedia-Social and Behavioral Sciences*, *210*, 416-424.

Drobetz, W., Menzel, C., & Schröder, H. (2016). Systematic risk behavior in cyclical industries: The case of shipping. *Transportation Research Part E: Logistics and Transportation Review*, *88*, 129-145.

Drobetz, W., Schilling, D.L., Tegtmeier, L., 2010. Common risk factors in the returns of shipping stocks. Maritime Policy and Management 37, 93–120.

Erdogan, O., Tata, K., Karahasan, B. C., & Sengoz, M. H. (2013). Dynamics of the co-movement between stock and maritime markets. *International Review of Economics & Finance*, *25*, 282-290.

Giannakopoulou, E. N., Thalassinos, E. I., & Stamatopoulos, T. V. (2016). Corporate governance in shipping: An overview. *Maritime Policy & Management*, *43*(1), 19-38.

Grelck, M. B., Prigge, S., Tegtmeier, L., & Topalov, M. (2009). Diversification properties of investments in shipping. *Journal of Alternative Investments*, *12*(1), 55-74.

Harris, R. (1995), Using Cointegration Analysis in Econometric Modelling. London : Prentice Hall.

Jawadi, F., Jawadi, N., & Cheffou, A. I. (2015). Are Islamic stock markets efficient? A time-series analysis. *Applied Economics*, *47*(16), 1686-1697.

Johansen, S. 1995. Likelihood-based inference in cointegrated autoregressive models. Oxford: Oxford University Press.

Kavussanos, M. G., Juell-Skielse, A., & Forrest, M. (2003). International comparison of market risks across shipping-related industries. *Maritime Policy & Management*, *30*(2), 107-122.

Merikas, A., Gounopoulos, D., & Nounis, C. (2009). Global shipping IPOs performance. *Maritime Policy & Management*, *36*(6), 481-505

Merikas, A., Gounopoulos, D., & Karli, C. (2010). Market performance of US-listed Shipping IPOs. *Maritime Economics & Logistics*, *12*(1), 36-64.

Panayides, P. M., Lambertides, N., & Cullinane, K. (2013). Liquidity risk premium and asset pricing in US water transportation. *Transportation Research Part E: Logistics and Transportation Review*, *52*, 3-15.

StataCorp. 2017. *Stata 15 Base Reference Manual*. College Station, TX: Stata Press.

Syriopoulos, T., & Tsatsaronis, M. (2011). The corporate governance model of the shipping firms: Financial performance implications. *Maritime Policy & Management*, *38*(6), 585-604.

Xiao, J. (2012). Relationship between the BDI and the stock price of domestic listed shipping companies—panel data analysis based on listed shipping ocmpanies, *Journal of the Shanghai Maritime University. 5*