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Analysis of seasonality patterns in container freight rates using HEGY method

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ABSTRACT

This paper strongly inspects the behavior of seasonality (deterministic) in container freight rates, and measures and compares seasonality patterns in different freight rate indices. We have performed deterministic seasonality unit root test in order to achieve set objectives. From this study we have a drawn conclusion that all the indices (tested in this paper) exhibit significant deterministic seasonality. For the months of January and August, there is no seasonal effect observed in all five series. Whereas all the indices except Exports from Europe rate index (EEI) exhibit significant seasonal patterns in the months of February, September and December. All five indices exhibit significant seasonality during May, and the coefficient sign shows a drop in the freight rates. During the months of March, October and November; it is observed that only EEI exhibit significant seasonal patterns. The results are extremely useful for carriers and agents who are involved in containerized freight transport business. Also, shippers can get a clear idea about the nature of the freight rates across various trade routes. This study is of great help to a broad category of stakeholders in containerized cargo transport business.

1. Introduction.

Ocean freight rate is a certain amount of price (depending upon the weight of cargo, nature of cargo, total distance of transportation and many other factors) charged by the carrier which is shipping line in context to containerized freight (packed and stuffed in shipping containers) for transporting cargo from port of loading to the port of destination. However, post-financial crises hit markets globally in 2008-09, Ocean freight transport sector became very volatile which has impacted and is impacting freight rate market, especially in case of containerized freight. This was primarily because of financial burden on shipping lines all around the globe as their market shares started contracting which was a result of weak demand for shipping services. Adding on to financial challenges, containerized freight market evidences consistent fluctuations in the freight rates largely because of seasonal factors. Seasonal fluctuation in ocean freight rates led to inconsistent performance and profits of shipping lines.

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1.1. Capacity Management and Freight rates.

Shipping industry has faced many challenges post financial crises in 2008-09, primarily tenacious miss-match between supply capacity and demand. Post crises, the demand struggled to pick momentum whereas the supply capacity added significantly by the shipping lines in order to gain market share. This resulted in freight rates remained under check. Ocean freight rates for containerized cargo have remained low and competition on major East-West and North-South routes have intensified. Market improved slightly in 2011-12 but for continuous efforts of shipping lines to add fresh capacity in the market, the capacity grew by about 8% demand by just 2% in 2015-16, which crippled the global container shipping. However, the demand improved and grew by about 3% in 2016 (Review of Maritime Transport, 2017). Strong contraction of new deliveries supported the supply-demand balance towards the end of 2016. Also, demand improved on prominent routes like Asia-Europe and also intra-Asia which was fueled up by robust growth in China's trade. Nevertheless, the lessening of supply-demand gap did not restore freight rates. Freight rates remained under check and shipping lines brawled to maintain profits on certain trade routes. In the second half of 2016, shipping lines scrapped comparatively newer ships and gave more importance to network optimization also deployed ships wisely during peak and slack season on various trade routes. This gave some momentum to freight rates and thus carriers could enjoy better margins after suffering for long. Cut through competition in the market has resulted in carrier consolidation and many carriers have gone bankrupt, especially the case of Hanjin Shipping.

In order to restore freight rates, shipping lines put their best efforts to manage supply-demand and implemented strategies like idling of ships and slow steaming. Cascading was yet another strategy which came in limelight, however cascading was pretty challenging on few routes. Ships up to 12,000 TEU size were deployed on transpacific and West Africa which led to deployment of even bigger ships on Asia-Europe and Asia-Mediterranean routes. Although, ship utilization rate on some routes were very low and thus rate restoration plans failed. Quite a large size of fleet is deployed on intra-Asia region as a result of developing economies growing rapidly but the trade volumes are constrained by infrastructural barriers at ports and in inland logistics.

Literature review also helps in laying the foundation for the theoretical development of the statistical model and this further helps what a study has been performed on a chosen topic. But the primary motive of literature review is to identify gaps in literature which becomes the base for next level of study. Therefore, 'why' becomes an important point which aims to study and identify important variables impact results in every research. This paper specifically meets the intents by intensively reviewing the available literature, keeping in mind the objectives of this study.

Freight rates mainly include base rates, Bunker Adjustment Factor (BAF), Origin Terminal Handling Charges (OTHC), Destination Terminal Handling Charges (DTHC), Peak Season Surcharges (PSS), Low Sulphur Surcharges (LSS), Bill of Lading charges (B/L Charges) and other miscellaneous charges. Freight rates are prone to fluctuate with intensifying market competition and this possess financial pressure on shippers. Cariou and Wolff (2006) exemplify relationship between the bunker adjustment factor (BAF) and bunker price and between the freight rate and charter rate, and also prove BAF to be the responsible ingredient for the volatility of the freight rates. Freight rates are also considered as important source of (Timotheos Angelidis; George Skiadopoulos, 2008). The paper goes on to set up Value at Risk (VaR) approach in order to measure risks originated due to ever fluctuating freight rates. The supply-demand mismatch often leads to miss-match, (Behrens and Picard, 2011) explains about often ships have less cargo to transport during backhaul which results in ships struggling with maintaining utilization. (Chen and Zeng, 2010) suggested a model based on mixed integer non-linear programming problem (MINP) which aims to optimize container shipping networks and operations and in the meantime tackle changing demand and freight rates. (Evans, 1977) states that stable freight rates are only possible if the supply demand conditions are stable which is just not possible, also confirms that through regression analysis done by many researchers finds out that on most liner routes a strong correlation between freight rate and stowage factor. (Fusillo, 2004) advocates the fact that cost savings by liner shipping companies should be passed on to shippers in the form of lower freight rates, also ordering new vessels and deploying vessels on a trade lane impacts freight rates in a long run. Often supply capacity adjustments on a trade route by liner shipping companies are the result of adjusting freight rates. If the freight rates face steep fall and if it seems to be a long-time affair then the liner companies may withdraw/suspend loops, opt missed sailings, lay-up vessels, cascade vessels to other trade routes or scrap older fleet. (Gouvernal and Slack, 2012) studies how container freight rates vary globally and regionally and over time. (Imai et al., 2006) states that the decision of deploying bigger ships on trades like Asia-Europe and Asia-North America is always considered keeping freight rates and feeder cost. And therefore, liner shipping companies' decision of ordering bigger ships for selected trades is considered after analyzing current freight rates on those trades and forecasting the same once the ships will be delivered (Lim, 2011). (Jansson and Shneerson, 1978) describes that freight rates do not contains marginal cost incurred in transporting cargo, which provides a positive aura to some industries but negative to others and therefore this protection offered by deviating from marginal cost is actually helpful in policy decision making. (Lu, 2007) mentions seven important points which are always impactful at any point in time of transporting freight through shipping containers, which are ocean freight rates, speed and reliability of the service, pilferage of cargo, inventory management, country's trade and company's policy, shipper market conditions, and the influence of the shippers' in the market. Freight rate plays an important role in the production of a container shipping service i.e. if the demand for shipping service exceeds available supply then the freight rates will rise, says (Lun, Pang and Panayides, 2010) and (Meyer, Stahlbock and Voß, 2012). (Luo, Fan and Liu, 2009) demonstrates an econometric analysis for volatile and fluctuating freight rates due to miss-match in demand of container shipping services and available supply capacity in the market. Yet another analytical study performed by (McGinnis, 1979) in order to read shipper's attitude towards an array of variables that affect freight transportation choice. (Munim and Schramm, 2017) introduce a state-of-the-art volatility forecasting method for container shipping freight rates with an example of Asia-North Europe trade route. (Ryoo and Thanopoulou, 1999) talks in detail about the formation of conferences wherein variety of forms of co-operation in liner shipping; it was in the Asian trades and India specifically where freight rate co-operation appeared for the first time during fall of 19^{th} century. (Slack and Gouvernal, 2011) explains the nature of ocean freight rates for transporting containerized cargo and the role various surcharges imposed on freight rates. Understanding the fact that maritime business is a highly capital intensive in nature and therefore, (Song et al., 2005) explains how overcapacity drives down freight rates, and this results in hampering profits of liner shipping companies'. (Tongzon, 2009) describes that efficiency of a container seaport or a terminal can be can be estimated by accessing it's turnaround time, cargo dwell time and the freight rates (Including or excluding inland haulage) charged by shipping companies for transporting certain amount of cargo through that particular port, therefore freight rate is an important component in selection of a port. (Wang, Liu and Bell, 2015) states that demand for container shipping is dependent on the freight rates and develops a mechanism that adjusts the freight rates to maximize the profit.(Wilmsmeier and Hoffmann, 2008) analyses the impacts of port infrastructure and liner shipping connectivity on freight rates by taking an example of Caribbean region. Below table briefs about various studies done on freight/charter rate volatility and seasonality in past in various segments of maritime shipping:

2. Research Methodology.

This contains three parts graph of sample data based prepared on log values, seasonal unit root test and deterministic seasonality. HEGY method is used to study the stochastic seasonality. Therefore, this paper adopts the HEGY method to test seasonal unit roots(Hylleberg et al., 1990). This paper uses the HEGY method because the sample size is not very large.

2.1. HEGY seasonality Analysis.

We test for seasonality in the container freight rates of EEI (Exports from Europe rate Index), EUI (Exports from US rate index), GFI (Global Freight Index), IEI (Imports to Europe index) and IUI (Imports to US index) using the HEGY unit root tests. To avoid the issue of scaling, we transform the series using logarithm. The log-transformed series are denoted as LEEI, LEUI, LGFI, LIEI and LIUI respectively. Table 3 present the results of seasonal unit root testing carried on the 5 indices. We estimate the p values using Monte-Carlo simulation methods. For LEEI, we are unable to reject the null of seasonal unit root at $\pm\pi/2$, $\pm 2\pi/3$ and $\pm 5\pi/6$. Similar behavior can be observed for other four indices, indicating that there is seasonal behavior present in the container freight rates under analysis.

Next, we model the deterministic stationarity present in the container freight series. The results are given in table 4. All the indices exhibit significant deterministic seasonality. For the months of January and August, there is no seasonal effect observed in all five series. Whereas all the indices except EEI exhibit significant seasonal patterns in the months of February, September and December. The sign of the coefficient is negative, indicating a drop in the freight rates. All five indices exhibit significant seasonality during May, and the coefficient sign indicates a drop in the freight rates. During the months of March, October and November; it is observed that only EEI exhibit significant seasonal patterns.

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Conclusions

This study assessed the impact and existence of seasonality (in container freight rates) and its types with timeline of existence. Paper also performs seasonal unit root test and checks deterministic seasonality of various indices of the freight rates. It is noticed that seasonality patterns in the freight rates of containerized cargo are characterized based on trade patterns, changing demand of commodities, supply capacity fluctuations, service flexibility, geopolitical factors and many other reasons. Broadly this study performs brief analysis and suggests that the seasonality patterns in certain routes for Container freights between Europe and USA Trade routes as well as General Freight Rate Index. Exports from Europe have seasonality in months of February, December and September where freight rates are seen to have fallen. This could be seen during Christmas and Chinese New Year time. October and November months seasonality are shown for all indices which indicate demand before Christmas. May month can be seen as slump period as drop in freight rates in all the routes could be noticed and monsoon could be seen as major disruption.

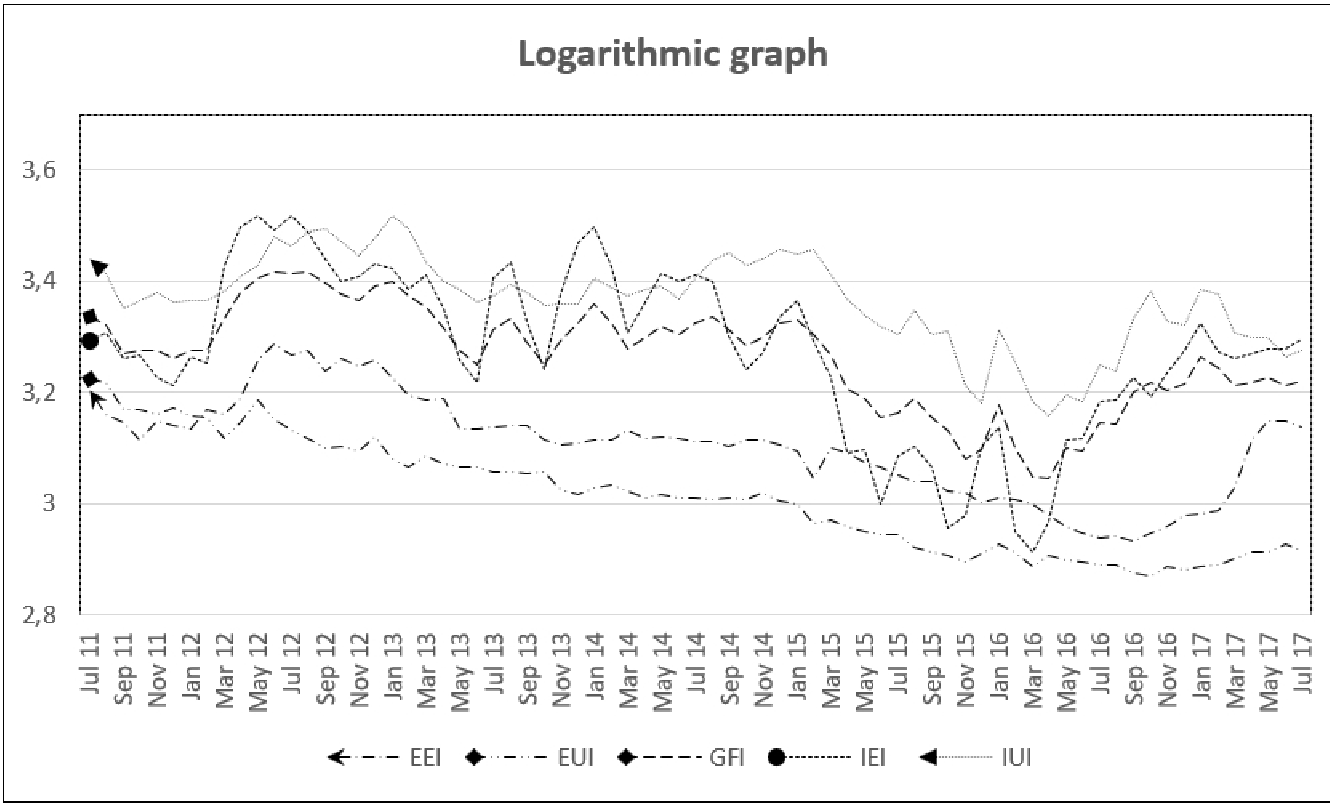
As discussed in the introductory section, freight rates on different trade routes are majorly influenced by fluctuations in the amount of supply capacity deployed, however sometimes weak demand volumes pressurizes rates and therefore carriers need to cut supply capacity in order to maintain utilization rates and therefore their earnings. When the demand and utilization rates are low, ship-owners opt for missed sailings and often send vessels for surveys and repair/maintenance, if pending or required. Ship-owners would want to maximize their revenue by entering into time charter market during peak seasons (Kavussanos and Alizadeh-M, 2001), while carriers and forwarders impose GRIs (General Rate Increase) during peak seasons. On the other hand, Shippers can use the said analysis to better optimize their shipments with lower costs and the same for buyers to plan their global supplies accordingly. The study also gives scope for shipping lines to plan and manage supply capacity in various regions and thereby increase revenue. Apart from above, their rates are also dependent on supply and demand for container services due sudden shocks.

Table 1: Some recent studies done on freight rate fluctuations and seasonality.

S. No.	Title and Author (s)	Scope	Methodology	Objective (s)
1	(Kavussanos and Alizadeh-M, 2002)	Tanker market	Markov Regime Switching Seasonal (MRSS) model	To find seasonality in tanker freight markets and compare across other sectors.
2	(Jing, Marlow and Hui, 2008)	Dry bulk shipping market.	GARCH and EARCH models	To evaluate volatility in dry bulk markets and in different vessels.
3	(Koekebakker and Os Ådland, 2004)	Dry bulk shipping market	Heath–Jarrow–Morton framework	To investigate the dynamics of forward freight rate dynamics in dry bulk shipping market.
4	(Poblacion, 2015)	Tanker market	Factor model for the stochastic behavior of TCE (Time Charter Equivalent) and WS (World Scale) prices.	To investigate seasonal behavior of freight rates and to find merits and demerits between stochastic seasonality and deterministic seasonality models.
5	(Li and Parsons, 1997)	Tanker market	Neural networks and ARMA time series models	To investigates the potential of neural networks for short- to long-term prediction of monthly tanker freight rates.
6	(Goulielmos and Psifia, 2007)	Dry bulk shipping market.	Rescaled range analysis (Hurst exponent)	To find time carter rates are independently distributed or nonlinear dependence.
7	(Alizadeh and Nomikos, 2011)	Dry bulk and tanker shipping market	EGARCH models	To find the relationship between time varying shipping freight rates volatility and term structure.
8	(Thuong and Ho, 1987)	Bulk cargo market	Descriptive study	To study volatility in charter rates in bulk cargo market.
9	(Manolis G Kavussanos, 1996)	Dry bulk shipping market.	Autoregressive Conditional Heteroscedasticity (ARCH)	To investigate volatility in the spot and time charter markets of dry-bulk vessels by using various ARCH class of models
10	(Xu, Yip and Marlow, 2011)	Dry bulk shipping market.	AR-GARCH model and GMM regression	To study relationship between the time-varying volatility of dry bulk freight rates and the change of the supply of fleet trading in dry bulk markets.

Source: Authors.

Figure 1: Logarithmic values of freight indices.



Source: Authors.

Table 2: Summary of Statistics of various Freight Indices.

Summary Statistics					
	EEI	**EUI**	**GFI**	**IEI**	**IUI**
Mean	1300.89	1058.06	1879329.00	1996.73	2360.11
S.D.	270.64	250.51	386.48	630.89	425.21
CV^b	73247.13	62757.16	149368.06	398016.62	180804.40
Skewness	0.37	0.61	-0.04	0.14	-0.14
Kurtosis	2.66	2.38	2.30	2.30	2.63
ARCH(12)c	389.90	456.01	348.71	213.22	219.23
L-B(12)d	423.33	507.04	377.07	264.10	234.32
J-B^e	2.01	5.71	1.52	1.70	0.67

Source: Authors.

Table 3: Seasonal Unit Root tests.

Frequency		LEEI	LEUI	LGFI	LIEI	LIUI
Constant	α_0	4.532 (0.000)	4.972 (0.067)	4.755 (0.012)	5.217 (0.002)	2.733 (0.052)
Trend	β_0	-0.006 (0.014)	-0.007 (0.079)	-0.007 (0.011)	-0.010 (0.004)	0.002 (0.088)
0	$\pi_1 = 0$	-2.839 (0.100)	1.924 (0.486)	2.737 (0.125)	-3.277 (0.037)	-1.979 (0.443)
$\pi = 0$	$\pi_2 = 0$	-1.958 (0.210)	-2.388 (0.0775)	-0.930 (0.732)	-1.156 (0.590)	-2.894 (0.027)
$\pm\pi/2$	$\pi_3 = \pi_4 = 0$	11.306 (0.000)	3.597 (0.151)	0.576 (0.873)	0.904 (0.776)	2.374 (0.381)
$\pm 2\pi/3$	$\pi_5 = \pi_6 = 0$	3.820 (0.1198)	1.998 0.458)	1.996 (0.475)	1.596 (0.565)	7.585 (0.002)
$\pm\pi/3$	$\pi_7 = \pi_8 = 0$	12.304 (0.000)	5.375 (0.044)	3.393 (0.183)	6.866 (0.017)	7.656 (0.004)
$\pm 5\pi/6$	$\pi_9 = \pi_{10} = 0$	4.421 (0.085)	3.385 (0.191)	1.757 (0.507)	2.549 (0.361)	4.855 (0.047)
$\pm\frac{\pi}{6}$	$\pi_{11} = \pi_{12} = 0$	11.140 (0.000)	8.044 (0.002)	6.060 (0.016)	5.057 (0.047)	8.416 (0.000)
	R^2	0.982	0.944	0.978	0.975	0.958
	DW	2.126	2.044	2.076	1.890	2.030

Source: Authors.

Table 4: Deterministic Seasonality in Container Freight Rates.

Month	Coefficient	LEEI	LEUI	LGFI	LIEI	LIUI
const	β_0	0.403 (0.144)	0.234 (0.196)	0.178 (0.642)	0.795 (0.086)	0.482 (0.386)
January	β_1	-0.004 (0.145)	-0.002 (0.208)	-0.002 (0.628)	-0.008 (0.084)	-0.005 (0.375)
February	β_2	-0.114 (0.091)	-0.172 (0.041)	-0.336 (0.006)	-0.218 (0.044)	-0.226 (0.004)
March	β_3	-0.375 (0.007)	-0.224 (0.094)	-0.098 (0.142)	-0.161 (0.014)	-0.089 (0.165)
April	β_4	-0.317 (0.036)	-0.253 (0.060)	-0.055 (0.427)	-0.012 (0.856)	-0.118 (0.073)
May	β_5	-0.478 (0.011)	-0.194 (0.064)	-0.598 (0.001)	-0.422 (0.009)	-0.448 (0.000)
June	β_6	-0.445 (0.006)	-0.183 (0.0872)	-0.550 (0.001)	-0.524 (0.001)	-0.463 (0.000)
July	β_7	-0.141 (0.001)	-0.124 (0.034)	-0.038 (0.248)	-0.002 (0.939)	-0.053 (0.124)
August	β_8	0.061 (0.145)	0.042 (0.470)	-0.042 (0.227)	-0.045 (0.166)	-0.028 (0.435)
September	β_9	-0.290 (0.060)	-0.352 (0.032)	-0.257 (0.030)	-0.358 (0.007)	-0.198 (0.025)
October	β_{10}	-0.414 (0.006)	-0.314 (0.054)	-0.169 (0.138)	-0.162 (0.233)	-0.254 (0.003)
November	β_{11}	-0.153 (0.019)	0.004 (0.951)	0.096 (0.206)	0.0002 (0.995)	-0.086 (0.258)
December	β_{12}	-0.064 (0.330)	-0.203 (0.008)	-0.274 (0.000)	-0.121 (0.006)	-0.177 (0.012)
	R^2	0.978	0.936	0.972	0.959	0.954
	DW	1.936	1.846	2.042	1.998	2.042

Source: Authors.

References

Alizadeh, A. H. and Nomikos, N. K. (2011) 'Dynamics of the term structure and volatility of shipping freight rates', Journal of Transport Economics and Policy, 45(1), pp. 105–128.

Behrens, K. and Picard, P. M. (2011) 'Transportation, freight rates, and economic geography', Journal of International Economics. Elsevier B.V., 85 (2), pp. 280–291. doi: 10.1016/j.jinteco.2011.06.003.

Chen, C. and Zeng, Q. (2010) 'Designing Container Shipping Network Under Changing Demand and Freight Rates', Transport, 25(1), pp. 56–57. doi: 10.3846/transport.2010.07.

Evans, J. J. (1977) 'Liner freight rates, discrimination and cross-subsidization', Maritime Policy and Management, 4(4), pp. 227–233. doi: 10.1080/03088837700000054.

Fusillo, M. (2004) 'Is liner shipping supply fixed?', Maritime Economics and Logistics, 6(3), pp. 220–235. doi: 10.1057-/palgrave.mel.9100110.

Goulielmos, A. M. and Psifia, M. (2007) 'A study of trip and time charter freght rate indices: 1968-2003', Maritime Policy and Management, 34(1), pp. 55–67. doi: 10.1080/0308883060-1103418.

Gouvernal, E. and Slack, B. (2012) 'Container freight rates and economic distance: a new perspective on the world map', Maritime Policy and Management, 39(2), pp. 133–149. doi: 10.1080/03088839.2011.650723.

Hylleberg, S. et al. (1990) 'Seasonal integration and cointegration', Journal of Econometrics, 44(1–2), pp. 215–238. doi: 10.1016/0304-4076(90) 90080-D.

Imai, A. et al. (2006) 'The economic viability of container mega-ships', Transportation Research Part E: Logistics and Transportation Review, 42(1), pp. 21–41. doi: 10.1016/j.tre.2004.07.-002.

Jansson, J. O. and Shneerson, D. (1978) 'The Effective Protection Implicit in Liner Shipping Freight Rates', The Review of Economics and Statistics, 60(4), p. 569. doi: 10.2307/1924250.

Jing, L., Marlow, P. B. and Hui, W. (2008) 'An analysis of freight rate volatility in dry bulk shipping markets', Maritime Policy and Management, 35(3), pp. 237–251. doi: 10.1080/030-88830802079987.

Kavussanos, M. G. and Alizadeh-M, A. H. (2002) 'Seasonality patterns in tanker spot freight rate markets', Economic Modelling, 19, pp. 747–782. doi: 10.1016/S0264-9993(1) 00078-5.

Koekebakker, S. and Os Ådland, R. (2004) 'Modelling forward freight rate dynamics - Empirical evidence from time charter rates', Maritime Policy and Management, 31(4), pp. 319–335. doi: 10.1080/03088830410001674197.

Li, J. and Parsons, M. G. (1997) 'Forecasting tanker freight rate using neural networks', Maritime Policy and Management, 24(1), pp. 9–30. doi: 10.1080/03088839700000053.

Lim, S. M. (2011) 'Economies of container ship size: a new evaluation', Maritime Policy and Management, 21(2), pp. 149–160. doi: 10.1080/03088839400000031.

Lu, C. S. (2007) 'Evaluating key resources and capabilities for liner shipping services', Transport Reviews, 27(3), pp. 285–310. doi: 10.1080/01441640600984015.

Lun, Y. H. V., Pang, K. W. and Panayides, P. M. (2010) 'Organisational growth and firm performance in the international container shipping industry', International Journal of Shipping and Transport Logistics, 2(2), p. 206. doi: 10.1504/ijstl.2010.03-0867.

Luo, M., Fan, L. and Liu, L. (2009) 'An econometric analysis for container shipping market', Maritime Policy and Management, 36(6), pp. 507–523. doi: 10.1080/03088830903346061.

Manolis G Kavussanos (1996) 'Comparisons of Volatility in the Dry-Cargo Ship Sector Spot versus Time Charters, and Smaller versus Larger Vessels', Journal of Transport Economics and Policy, 30(1), pp. 67–82. Available at: http://www.jstor.org/-stable/20053097%5Cnhttp://www.jstor.org/stable/20053097.

McGinnis, M. A. (1979) 'Transportation Choice: A Factor Shipper Attitudes Toward Freight Analytic Study', International Journal of Physical Distribution & Logistics Management, 45(1/2), pp. 69–89. doi: 10.1108/IJPDLM-05-2013-0155.

Meyer, J., Stahlbock, R. and Voß, S. (2012) 'Slow steaming in container shipping', Proceedings of the Annual Hawaii International Conference on System Sciences, pp. 1306–1314. doi: 10.1109/HICSS.2012.529.

Munim, Z. H. and Schramm, H. J. (2017) 'Forecasting container shipping freight rates for the Far East-Northern Europe trade lane', Maritime Economics and Logistics. Palgrave Macmillan UK, 19 (1), pp. 106–125. doi: 10.1057/s41278-016-0051-7.

Poblacion, J. (2015) 'The stochastic seasonal behavior of freight rate dynamics', Maritime Economics and Logistics. Nature Publishing Group, 17(2), pp. 142–162. doi: 10.1057/mel.-2014.37.Review of Maritime Transport (2017). New York and Geneva.

Ryoo, D. and Thanopoulou, H. (1999) 'Liner alliances in the globalization era: a strategic tool', Maritime Policy & Management, 26(4), pp. 349–367.

Slack, B. and Gouvernal, E. (2011) 'Container freight rates and the role of surcharges', Journal of Transport Geography. Elsevier Ltd, 19 (6), pp. 1482–1489. doi: 10.1016/j.jtrangeo.2011-.09.003.

Song, D. et al. (2005) 'On cost-efficiency of the global container shipping network', Maritime Policy and Management, 32(1), pp. 15–30. doi: 10.1080/0308883042000176640.

Thuong, L. T. and Ho, C. (1987) 'Coping with International Freight Rate Volatility', Journal of Purchasing and Materials Management, 23(3), pp. 29–35. doi: 10.1111/j.1745-493x.1987.tb00189.x.

Timotheos Angelidis; George Skiadopoulos (2008) 'Measuring the Market Risk of Freight Rates: a Value-At-Risk Approach', International Journal of Theoretical and Applied Finance, 11(5), pp. 447–469. doi: 10.1142/s0219024908004889.

Tongzon, J. L. (2009) 'Port choice and freight forwarders', Transportation Research Part E: Logistics and Transportation Review. Elsevier Ltd, 45(1), pp. 186–195. doi: 10.1016/j.tre.20-08.02.004.

Wang, S., Liu, Z. and Bell, M. G. H. (2015) 'Profit-based maritime container assignment models for liner shipping networks', Transportation Research Part B: Methodological. Elsevier Ltd, 72, pp. 59–76. doi: 10.1016/j.trb.2014.11.006.

Wilmsmeier, G. and Hoffmann, J. (2008) 'Liner shipping connectivity and port infrastructure as determinants of freight rates in the Caribbean', Maritime Economics and Logistics, 10(1–2), pp. 130–151. doi: 10.1057/palgrave.mel.9100195.

Xu, J. J., Yip, T. L. and Marlow, P. B. (2011) 'The dynamics between freight volatility and fleet size growth in dry bulk shipping markets', Transportation Research Part E: Logistics and Transportation Review. Elsevier Ltd, 47(6), pp. 983–991. doi: 10.1016/j.tre.2011.05.008.