THE RELATIONSHIP BETWEEN MARITIME FUEL SURCHARGES DEVELOPMENT AND ECONOMIC GROWTH

Monika Skalská

Abstract

The topic of this article is to present an analysis of relationship between maritime surcharges (fuel surcharge) and development of the economy (represented by bunker prices development). Pricing in the maritime industry is turbulent. Ship-owners or ship operators and shippers are subject to fluctuations in prices. These fluctuations affect the financial opportunities of companies because they determine cash flows and have a significant affect planning. According to conducted researches, the freight charges depend mainly on fixed factors, while surcharges are time-sensitive. Therefore, the article is focused on the development of fuel surcharges in the last five years (from fourth quarter of 2015 to first quarter of 2019) and points to the need to clearly identify their development in relation to the development of the economy. Methodology of the article uses statistical methods related to the analysis of time series. Conclusions of the article can offer several measures for future researchers.

Keywords: maritime industry, time series, fuel surcharges

JEL Code: C30, R40

Introduction

According to Wu & Huang (2018), sea container shipping has undergone several major changes in recent years. These changes were caused by external influences. One of the influences is to change the competitive environment. The competitive environment has changed significantly due to changes in prices and tariffs. There was a shift from public tariffs to individual tariffs (Wang, 2012). The second influence is the development of world trade. The correlation between maritime transport and economic development has already been examined in the past. But Hoffmann & Kumar (2010) noted that a more thorough assessment of the relationship is still sufficient. The third significant influence, according to Wu & Huang

(2018), is the rise in input prices. This effect has an impact on operating costs. Above all, it is the cost of fuel on world market (Notteboom & Vernimmen, 2009; Yao, Ng & Lee, 2012; Zhen, Shen, Wang & Yu, 2016; Wang, Meng & Kuang, 2018). The development of bunker fuel prices, according to Stefanakos & Schinas (2014) and Wang, Meng & Kuang (2018), are closely linked to world gross domestic product (GDP) developments and thus to the above-mentioned economic development.

1 The relationship between maritime surcharges development and economic growth

The fluctuations of bunker fuel costs over time affect business planning and viability of companies (De Oliveira, 2014; Stefanakos & Schinas 2014). For these time-sensitive inputs, their prediction is important (Stefanakos & Schinas 2014, Wang, Meng & Kuang, 2018).

Ship-owners compensate price fluctuations with use the flexible surcharges. The most common surcharge is the fuel surcharge (De Oliveira, 2014). The surcharge was introduced in 1974 in connection with oil crisis (Slack & Gouvernal, 2011; Wang, Chen & Lai, 2011). This surcharge is intended to cover the increase in fuel costs (Blom & Borisson, 2008; Oblak, Jugović & Perić Hadžić, 2016). As a result, ship-owners transfer the risk of changing inputs to customers (Stefanakos & Schinas, 2014; Johnson & Styhre, 2015; Wu & Huang, 2018). However, the surcharge is often the subject of disputes between ship-owners and customers (Slack & Gouvernal, 2011). The question is the justification for the fuel surcharge and its link to changes in bunker prices on world market (Wolff & Cariou, 2006; Slack & Gouvernal, 2011; Wang, Chen & Lai, 2011).

With respect to, the article focuses on the bunker fuel price relationships on world markets and fuel surcharges. Slack & Gouvernal (2011) analyzed generally various surcharges used in maritime transport. Specifically, Wolff & Cariou (2006) examined relationship between the bunker fuel price relationships on world market and fuel surcharge. To describe the relationship between Wolff & Cariou (2006), authors used Granger's causality. Wang, Chen & Lai (2011) and Stefanakos & Schinas (2014) researched a question of mutual causality, too.

2 Methods

The cointegration analysis is a modern method for the analysis of non-stationary variables. Cointegration analysis can be done using numerical tests or graphical methods. The numerical test can be selected – the Engle-Granger test.

Numerical cointegration analysis consisted of two basic steps. The first is a unit root test and the second is a cointegration test of two variables. The conditions have to be met before testing. It is necessary to determine an optimal lag length. It is necessary data to be stationary.

The optimal lag length can be determined using the Aikaike Information Criterion (AIC), see Formula (1) where *n* is the number of observations, *RSS* the mentioned residual sums-of-squares and *k* number of parameters. The criterion is recommended for fewer observations (up to 60 observations).

$$AIC = n \times log\left(\frac{RSS}{n}\right) + 2k \tag{1}$$

The next step is to perform the unit root test. The test can determine whether the time series are stationary or non-stationary. The test can be performed using the Kwiatkowski-Phillips-Schmidt-Schin test (KPSS test). KPPS test is based on LM test of the hypothesis that the random walk has a zero variance.

The test can determine non-stationarity. There it is necessary to adjust the time series and repeat the test. The time series can be purified by a Hodrick-Prescott filter, see Formula (2), where y is a variable and y_t^* is a purify variable. This time series filter removes the cyclical component.

$$\min_{\{y_t^*\}}\left[\sum_{t=1}^{T}\left(y_t - y_t^*\right)^2 + \lambda\sum_{t=2}^{T}\left[\left(y_{t+1}^* - y_t^*\right) - \left(y_t^* - y_{t-1}^*\right)\right]^2\right] \tag{2}$$

After demonstrating the stationarity of the adjusted time series, it is possible to progress with cointegration test. The Engle-Granger test can be used, see Formula (3), where e_t are estimated residue, k is the number of optimal lag length and ε_t are residue.

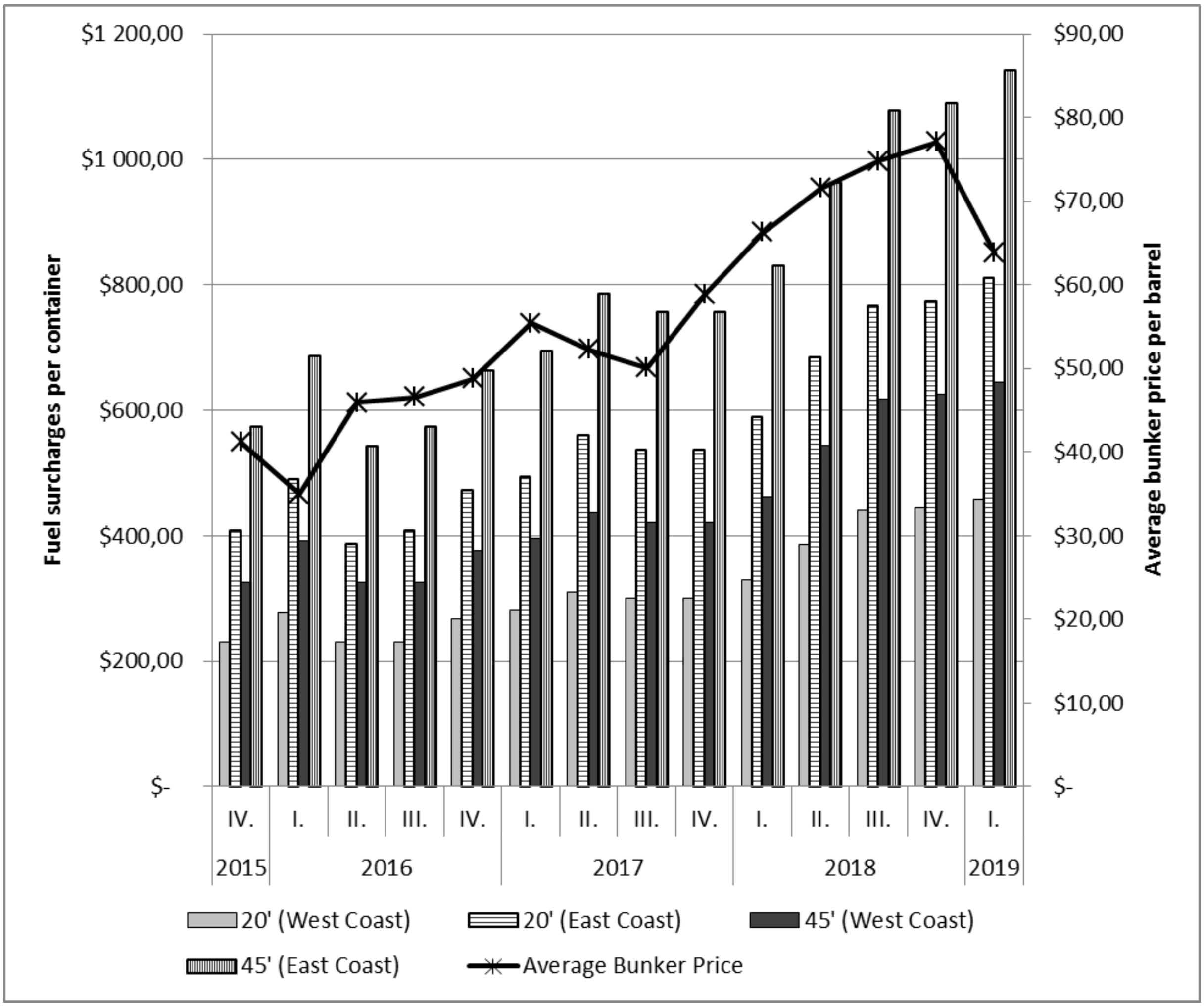
$$\Delta e_t = \varnothing e_{t-1} + \sum_{i=1}^{k} \alpha_1 \Delta e_{t-1} + \varepsilon_t \tag{3}$$

3 Data

The data was obtained from Hapag-Lloyd (fuel surcharge) and from the database of company Kurzy (average bunker price). The data (fuel surcharge) are presented for all dry, reef flat racks and open-top containers from East Asia and Indian Subcontinental to all US and Canada destinations. The data are divided by type of container (20 feet - all types, 45 feet - standard type) and by destination (West Coast, East Cost).

These were secondary data. This was a complete dataset from fourth quarter of 2015 to first quarter of 2019 (see Fig. 1). The data in the Fig. 1 is given in US dollars.

Fig. 1: The development of fuel surcharges and the development of average bunker price



Source: author with use Hapag-Lloyd (2019), Kurzy (©2000 – 2019)

4 Results

The data are quarterly and the seasonal component was removed. Moving averages were used. After that the AIC test was done. To test the relationship between average bunker price (exogenous variable), and the development of fuel surcharges (endogenous variable), optimal lag length was determined at 3 (see Tab. 1). The optimal lag length was used in the next calculation.

Tab. 1: The optimal lag length

The optimal lag length	AIC			
	20 feet (West Coast)	20 feet (East Coast)	45 feet (West Coast)	45 feet (East Coast)
1	5,947089	7,285446	6,646134	7,939396
2	6,191593	7,432807	6,890012	8,093092
3	5,703311	6,955503	6,355411	7,603065

Source: author using the Gnu Regression, Econometrics and Time-series Library

A stationarity test of time series was performed. The KPSS test was used. A zero hypothesis (H0: time series are stationary) at 95% significance level was tested. The significance level was compared with the *p*-value (see Tab. 2).

Tab. 2: Results of the KPSS test

Variable	*p*-value	H0
20 feet (West Coast)	0,040	reject the null hypothesis
20 feet (East Coast)	0,038	reject the null hypothesis
45 feet (West Coast)	0,040	reject the null hypothesis
45 feet (East Coast)	0,038	reject the null hypothesis
Average bunker price	0,040	reject the null hypothesis

Source: author using the Gnu Regression, Econometrics and Time-series Library

The test determined non-stationarity. It was necessary to adjust the time series and repeat the test. The time series were purified by a Hodrick-Prescott filter. It was used the recommended λ-value for the quarterly time series, $\lambda = 1\ 600$. The second stationarity test of time series was performed. The adjusted data was used. A zero hypothesis (H0: time series are stationary) at 95% significance level was tested. The significance level was compared with the *p*-value. In all cases, the *p*-value was over 0.065.

After demonstrating the stationarity of the time series, it was possible to continue the cointegration test. The Engle-Granger test was used. A zero hypothesis (H0: time series are not cointegrated) was tested at a 95% significance level. The Engle-Granger test offers three basic models for cointegration testing. It is a non-constant model, a model with constant, or a model with a constant and trend. A model with constant was selected. For this model the *p*-value was calculated (see Tab. 3).

Tab. 3: Results of the Engle-Granger test

Variable	*p*-value
20 feet (West Coast)	1,00E-24
20 feet (East Coast)	2,97E-26
45 feet (West Coast)	1,04E-24
45 feet (East Coast)	2,53E-26

Source: author using the Gnu Regression, Econometrics and Time-series Library

The *p*-value is lower than the test statistic. It is possible to reject the null hypothesis. There is the cointegration between time series.

5 Discussion

The relationship between maritime surcharges development and economic growth is solved by a few scientists. The aim of this article was to analyze the part of maritime surcharges (fuel surcharge) and to focus on this sub-part of the pricing in relationship to bunker prices development. The research question was whether the development of bunker prices directly influences the development of the fuel surcharges.

The relationship has been confirmed for the chosen line (from East Asia and Indian Subcontinental to all USA and Canada destination) in the period from fourth quarter of 2015 to first quarter of 2019, based on the research results (Chapter 4). The cointegration between time series has been identified. The cointegration of time series means that the development of individual time series does not deviate in the long run. Similarly, the relationship between fuels surcharge and factors of development of the economy was identified by other scientists, for example Wolff & Cariou (2006) or Slack & Gouvernal (2001). However, Slack & Gouvernal (2011) note that there are significant regional differences that affect this relationship.

It is important to remember that the results are conditional on the data set. They were used quarterly time series. More detailed data could also be used in future research.

Conclusion

The cointegration between the part of maritime surcharges (fuel surcharge) and bunker prices development has been demonstrated. Analysis of cointegration is important in economic systems. These systems may be affected by random variances in the short term.

Not all sphere of relationship have been resolved, but the article provides new data. It is appropriate to analyze separately the individual parts of the fuel surcharges and to focus on communication with customers.

It is appropriate to adopt conceptual decisions in this area – the relationship between ship-owner costs and surcharges should be clearly defined.

References

Blom, J. & Borisson, L. (2008). Cost breakdown and surcharge mapping for sea freight. Available from websites of Lund University: http://www.tlog.lth.se/fileadmin/tlog/Utbildning/Examensarbete/2009/Exjobb/5672_Blom-Borisson.pdf

De Oliveira, G. F. (2014). Determinants of European freight rates: The role of market power and trade imbalance. *Transportation Research Part E: Logistics and Transportation Review, 62*, 23-33. doi: 10.1016/j.tre.2013.12.001

Hoffmann, J. & Kumar, S. (2010). Globalisation – the maritime nexus. In: Grammenos, C., The *Handbook of Maritime Economics and Business*, (pp. 67–97). Informa Law from Routledge: London.

Johnson, H. & Styhre, L. (2015). Increased energy efficiency in short sea shipping through decreased time in port. *Transportation Research Part A: Policy and Practice, 71*, 167-178. doi: 10.1016/j.tra.2014.11.008

Notteboom T. E. & Vernimmen, B. (2009). The effect of high fuel costs on liner service configuration in container shipping. *Journal of Transport Geography, 17*(5), 325-337. doi: 10.1016/j.jtrangeo.2008.05.003

Oblak, R., Jugović A. & Perić Hadžić, A. (2016). Defining freight rates as a contribution to the successful operation of container shipping companies. *Management, 21*(2), 145-163. Available from: https://hrcak.srce.hr/file/260011

Slack, B. & Gouvernal, E. (2011). Container freight rates and the role of surcharges. *Journal of Transport Geography, 19*(6), 1482-1489. doi: 10.1016/j.jtrangeo.2011.09.003

Stefanakos, Ch. N. & Schinas, O. (2014). Forecasting bunker prices; A nonstationary, multivariate methodology. *Transportation Research Part C: Emerging Technologies (38),* 177-194. doi: 10.1016/j.trc.2013.11.017

Wang D., Chen, Ch. & Lai, Ch. (2011). The rationale behind and effects of Bunker Adjustment Factors. *Journal of Transport Geography, 19*(4), 467-474. doi: 10.1016/j.jtrangeo.2009.11.002

Wang, D. (2012). Ocean shipping reform act promotes competition in the trans-Atlantic trade route. *Transport Policy, 23,* 88-94. doi: 10.1016/j.tranpol.2012.06.007

Wang. Y., Meng, Q. & Kuang, H. (2018). Jointly optimizing ship sailing speed and bunker purchase in liner shipping with distribution-free stochastic bunker prices. *Transportation Research Part C: Emerging Technologies, 89,* 35-52. doi: 10.1016/j.trc.2018.01.020

Wolff, F.-Ch. & Cariou P. (2006). An Analysis of Bunker Adjustment Factors and Freight Rates in the Europe/Far East Market (2000–2004). *Maritime Economics & Logistics, 8*(2), 187-201. doi: 10.1057/palgrave.mel.9100156

Wu, W. & Huang, D. (2018). Modelling the profitability of container shipping lines: Theory and empirical evidence. *Transport Policy, 72*, 159-170. doi: 10.1016/j.tranpol.2018.01.008

Yao, Z., Ng, H. & Lee, L. H. (2012). A study on bunker fuel management for the shipping liner services. *Computers & Operations Research, 39*(5), 1160-1172. doi: 10.1016/j.cor.2011.07.012

Zhen, L., Shen T., Wang, S. & Yu, S. (2016). Models on ship scheduling in transshipment hubs with considering bunker cost. *International Journal of Production Economics, 173,* 111-121. doi: 10.1016/j.ijpe.2015.12.008

Contact

Monika Skalská

University of Pardubice, Faculty of Transport Engineering

95 Studentská, 532 10 Pardubice, The Czech Republic

monika.skalska@upce.cz