THE ANALYSIS OF THE SPECIFICS OF CONTAINERISED CARGO MOVEMENTS ON "CHINA-BALTIC STATES" SHIPPING ROUTE

Jelena Mikulko

Transport and Telecommunication Institute, Latvia

crossref http://dx.doi.org/10.5755/j01.em.18.4.5067

Abstract

Maritime industry is a very important economic sector and it has a direct impact on the prosperity of the Baltic States. World containerised cargo turnover increases approximately by 10% each year, but "China-Europe/Asia" trade has increased dramatically in recent years, and imports from China are significant. For Baltic States it is very important mainly because they have transit ports for containerised cargoes shipped from China to CIS (Commonwealth of Independent States) countries and about 80% of containerised cargoes handled in ports of Baltic States are transit flows.

But in terms of future prospects, Baltic States could lose a lot of containerised transit cargo flows because of the strong competition between ports and clear-cut ascendancy of alternative routes. Therefore, it is particularly relevant for the Baltic States to develop such competitive transit container freight traffic management schemes that would keep the existing and attract the new flows of containerised goods through the ports of the Baltic States.

Thereby, the objective of this research is identification of factors, which determine the specifics of the containerised cargo ship movements between sea ports with the stress on "China – Baltic States" shipping route and identification of the competitive advantages and disadvantages of this route as opposed to other routes (railway mode of transportation from China through Kazakhstan territory and shipments from China to Russian Far Eastern sea ports coupled with railway transportation through Russian territory).

The principles on which the selection of the above-mentioned factors has been done are presented in this paper. Herewith, the methods of multivariate statistical analysis are used for the systemization process. The deep and detailed analysis of routes, the specifics of services, and the "main market players" has been done.

An integral, comprehensive view on the specifics of containerised cargo ship movements between sea ports on "China–Baltic States" trade line has been created. The results allow to evaluate the formation laws of containerised cargo shipments on "China–Baltic States" trade line, to understand the variability dynamics of cargo flows inside mentioned network, to determine the invariance of network. Furthermore the identification of definitive competitive advantages and disadvantages of this route as opposed to other routes has been accomplished (difference in delivery lead-times, difference in price level for transportations of standard and overweight cargoes).

The type of the article: *Research paper.*

Keywords: *containers, Baltic States, transit container flows, management schemes.*

JEL classification: *R11, N70, R40.*

1. Introduction

Cargo transportation by sea is one of the most important modes of transportation because about 90% of world trade is hauled by ships. There are several modes of transportation cargo by sea but exactly containerized cargo turnover increases approximately by 10% per year (Kaluza *et al.*, 2010). Containerships carry up non bulk cargo in containers. Nowadays, about 90% non-bulk cargo in the world is transported in containers, and container vessels of the latest generation can carry up to 18,000 TEUs. Recent research by global industry analysts advises that world maritime containerisation market is set to reach an impressive 731.88 million TEUs (Twenty-foot equivalent units) by 2017.

At the same time "China-Europe/Asia" trade has increased dramatically in recent years, and imports from China are significant. For Baltic States it is very important because they have transit ports for containerised cargoes shipped from China to CIS (Commonwealth of Independent States) countries. For example the Russian container market is one of the fastest growing markets in the world and the Russian cargo has made up 12 percent of overall cargo handling in the port of Klaipeda but in the ports of Riga and Tallinn it makes up to 70 percent.

But in terms of future prospects the Baltic States could lose a lot of transit cargo flows because of strong competition between ports (11 Baltic ports compete for cargoes going to CIS) and clear-cut ascendancy of alternative routes. Meanwhile differently from rail, air and road networks there has been paid quite little attention to the maritime network. Especially there has been paid quite little attention to the investigation of "China – Baltic States" trade line. That's why an integral, comprehensive view on the specifics of containerised cargo movements on "China-Baltic States" shipping route should be created. It is necessary for further development of competitive transit container freight traffic management schemes.

2. Method

Increasing international trade influences the increase of necessity of the greater transport, logistics and communications facilities such as ports, terminals, and road and rail transport networks around the globe, which in turn drives growth in global economies. There are approximately 500 liner shipping services that enable to move goods between ports along the many trade routes of the world (Deng *et al.*, 2009). The biggest amount of services connected to Far East area (see Figure 1).

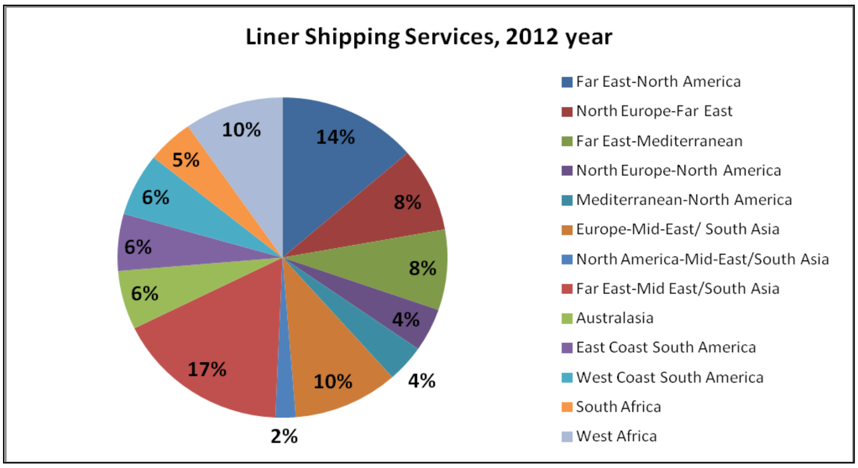

Figure 1. Liner Shipping Services, 2012 year

Source: adapted by the author with reference to Mikulko (2012)

At the same time the centre of gravity of these liner service networks has shifted to Asia and the dominance of China is reflected in world container port rankings (see Figure 2).

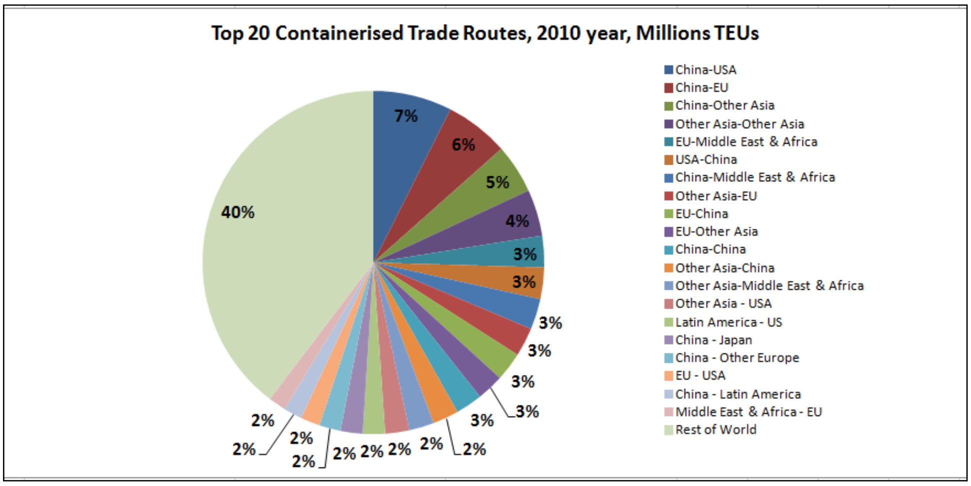

Figure 2. Top 20 Containerized Trade Routes, 2010 year, Millions TEUs

Source: adapted by the author with reference to Mikulko (2012)

The "China-European Union" trade is one of the largest trade route in the world and it is increasing dramatically (Slack *et al.*, 2009). This route consists of cargo with destination not only in European Union but also transit cargoes with destination countries: Russia, Belorussia, Kazakhstan and other CIS countries.

Therefore 8% of world lines shipping services belong to serving the „Far East-North Europe" shipping route which consists mainly of trade between China and EU, CIS countries. China is responsible for about 30% of world container-handling activity. China remains the manufacturing engine of the world (Slack *et al.*, 2009).

As the main route for further analysis the route "Shanghai-Riga-Moscow" was chosen. The Moscow is the financial and political centre of Russia, but the port of Shanghai is the leader between worlds container ports on the basis of volume of containers handled in (Hu, Zhu, 2009). The port of Shanghai takes nearly half of the total container traffic through all ports in China and containerization is high at Shanghai port, reaching above 55 percent (Song *et al*., 2004).

One of main factors that influence on the containerised cargo movements on "China-Baltic States" shipping route is delivery lead time. For this route there are five main competitive logistics solutions (see Figure 3).

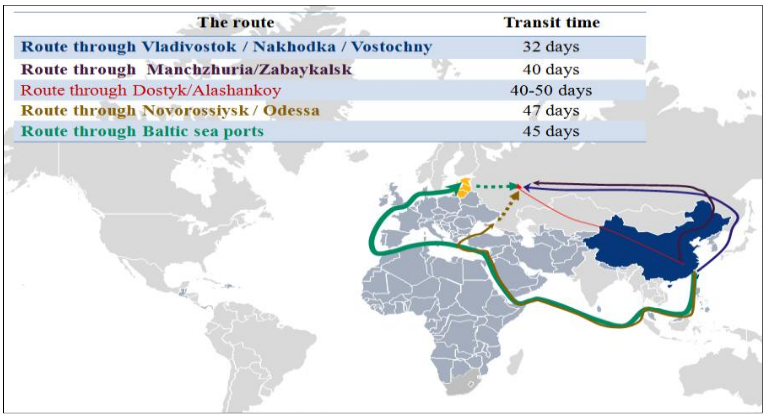

Figure 3. Deliveries lead time from Shanghai to Moscow

Source: adapted by the author with reference to Mikulko (2012)

As we can see according to this factor the transportation through the Baltic Sea is not competitive. The liner shipping sector is one of the most dynamic segments of ocean transportation and the prices for sea freight transportation have significant importance and this is one of main factors that influence the situation in container logistics area on this route (Noteboom, 2006). The route through the Baltic Sea is one of the cheapest even for overweigh cargoes according to the price indexes illustrated below (see Figure 4).

The route	Price index for cargo till 20 t. brutto weight "standard cargo"	Price index for cargo over 20 t. brutto weight "overweight cargo"
Route through Vladivostok / Nakhodka / Vostochny	1,23	1,13
Route through Manchzhuria/ Zabaykalsk	1,53	1,39
Route through Dostyk/ Alashankoy	1,54	1,40
Route through Novorossiysk / Odessa	1,01	1,01
Route through Baltic sea ports	1,00	1,00

Figure 4. Price indexes for cargoes

Source: adapted by the author with reference to Mikulko (2012)

There is a huge instability on the market (Notteboom, 2006). Each month the prices on "China-Europe" shipping route could increase and decrease and changing could reach 800 USD per TEU (twenty-foot equivalent unit (Heaver, 2010).

The most important is to have possibility for forecasting prices in advance (Mikulko, 2012).

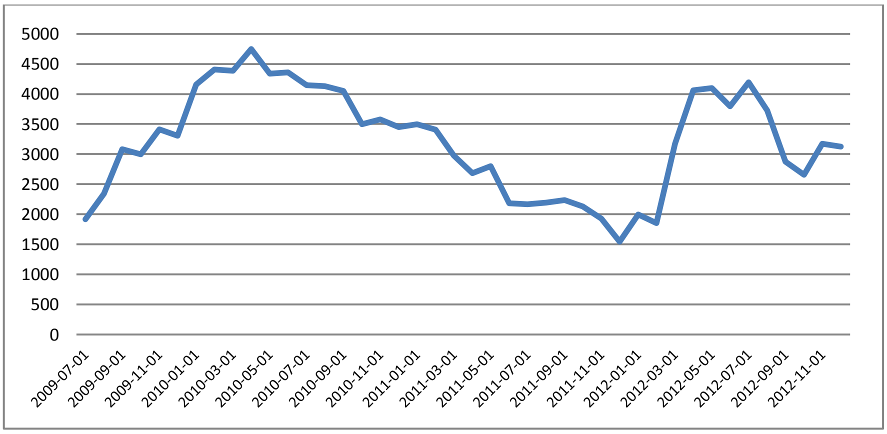

Figure 5. Sea freights on "Shanghai-Riga" shipping route for 40'DC container, 2009-2012 years, USD

Source: adapted by the author with reference to Mikulko (2012)

To have possibility for forecasting prices there were key factors that influence the price level on "Shanghai – Riga port" trade line determined. The regression analysis which is a statistical technique for studying linear relationships was applied here.

Since the fiscal crisis of 2008, the growth in container traffic has become less predictable, from a fall of almost 11 % in 2009 to more than 12% in 2010. And now growth is slowing. This is closely related to global economic growth prospects, with Europe particularly lacklustre.

In collaboration with the Financial Times, Eswar Prasad and Karim Foda (Financial Times (2013) have developed a set of composite indexes which track the global economic recovery (see Figure 6).

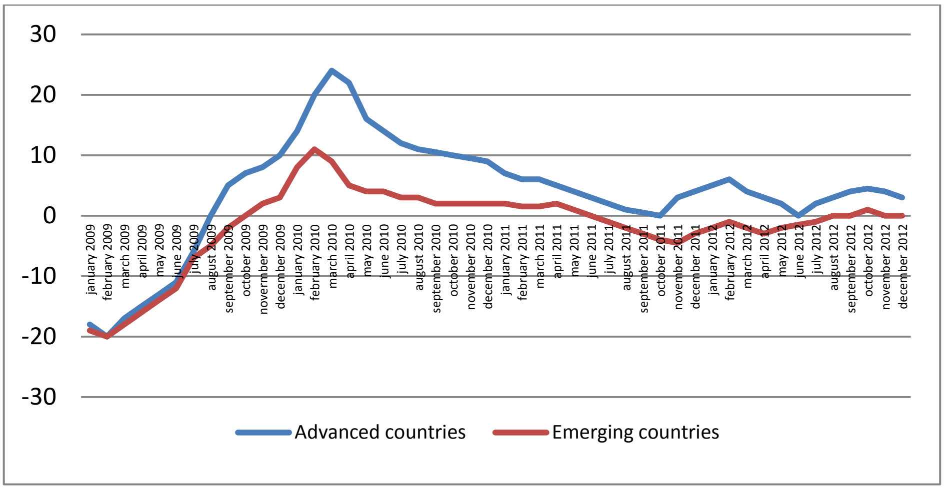

Figure 6. Tracking Index for Global Economic Recovery (TIGER) – overall growth

Source: adapted by the author with reference to Financial Times (2013)

The regression model was developed to predict prices on „China - Baltic States" shipping route. The independent variable is price for 40'dry container on the route Shanghai port – Riga port, and there are four dependent variables (see Table 1). Prices have been taken by Author from the statistics of three main Shipping Companies in the industry and based on his own analysis. The prices are taken on "FI-LO terms" – as the most popular conditions in the international trade expertise on this route (Rodrigue *et al.*, 2009). That means that price includes sea freight and local charges in the port of destination. There are 48 cases in the model (48 months for the period from January of 2009 year till the December of 2012 year).

Table 1. Variables and their description

No.	Variable	Description
1	Y (dependent variable)	Price for 40'dry container on the route Shanghai port – Riga port
2	X1 (independent variable)	Idle containerships capacity in TEU with 3 month retrospective
3	X2 (independent variable)	A set of composite indexes which track the global economic recovery (Tracking Indexes for the Global Economic Recovery-TIGER), advanced countries
4	X3 (independent variable)	A set of composite indexes which track the global economic recovery (Tracking Indexes for the Global Economic Recovery-TIGER), emerging countries
5	X4 (independent variable)	A set of composite indexes which track the global economic recovery (Tracking Indexes for the Global Economic Recovery-TIGER), average index (advanced & emerging countries)

Source: adapted by the author with reference to Nisbet *et al.* (2009)

Tracking Index for the Global Economic Recovery (TIGER) was chosen by Author as independent variable because the "China-Baltic States" shipping line is a part of great shipping routes for cargoes going from Far East region to CIS countries and prices on this market are like the mirror to the economic situation and recent economical changes in the World. There are two indexes – for advanced and emerging countries and another one – average index between two mentioned.

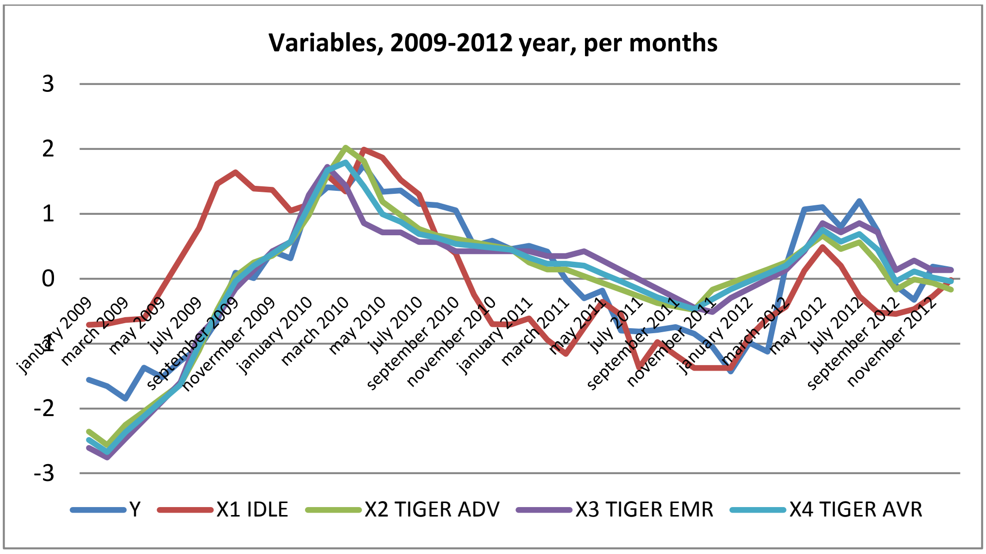

Figure 7. Variables used in the regression model, 2009-2012 year, per months

Source: adapted by the author with reference to Nisbet (2009)

3. Results

The 1st regression model will be based on using three independent variables: X1, X2, X3 (see Table 2).

Table 2. The analysis of the 1st multiple regression model

Parameters		Results		
Regression Summary:		$\hat{Y} = 0.276 \times X_1 + 0.332 \times X_2 + 0.426 \times X_3$		
R:		0,90267		
R2:		0,81482		
Adjusted R2:		0,80219		
Standard Error of Estimate:		0,44474		
Results of the ANOVA				
Regression Sum of Squares	**Degrees of freedom**	**Residual Sum of Squares**	**Degrees of freedom**	
ESS=38,29677	df1=3	RSS=8,70323	df2= 44	
F:	64,53766	P-level:	0.00000	
Analysis of the coefficients of the model				
Independent variable	**Coefficient**	**Standard Error of Coefficient**	**t**	**p-level**
X_1	0,27596	0,07863	3,50946	0,00104
X_2	0,33222	0,26513	1,25305	0,21680
X_3	0,42627	0,25138	1,69569	0,09700

Source: adapted by the author with reference to Nisbet (2009)

Idle containerships capacity (X1) in TEU with 3 month retrospective means the containership fleet that were not used on trade routes for about 3 month ago.

On the base of regression analysis results it is possible to conclude that we can't accept the hypothesis about model non-significance according to significance level (0.05). R-Squared is given directly in terms of the explained variance: it compares the explained variance (variance of the model's predictions) with the variance (of the data). In a multiple linear regression model, adjusted R-Squared measures the proportion of the variation in the dependent variable accounted for by the explanatory variables. Unlike R-Squared, adjusted R-Squared allows for the degrees of freedom associated with the sums of the squares. Both are quite high, close to 1. An F-test is any statistical test in which the test statistic has an F-distribution under the null hypothesis. It is most often used when comparing statistical models that have been fit to a data set, in order to identify the model that best fits the population from which the data were sampled. Exact F-tests mainly arise when the models have been fit to the data using least squares. Here it is equal to 64,53766. But if we will look at analysis of the coefficients of the model, we could conclude that two of them have p-level higher than significance level (0.05). That means that we accept the hypothesis about coefficients non-significance according to significance level 0.05. Standard Error of Coefficients is too high as well.

There could be multicollinearity as the correlation coefficient between variables is high (see Table 3).

Table 3. Correlations coefficients

	X1	**X2**	**X3**	**Y**
X1	1,00000	0,47422	0,37123	0,59176
X2	0,47422	1,00000	**0,96133**	0,87288
X3	0,37123	**0,96133**	1,00000	0,84810
Y	0,59176	0,87288	0,84810	1,00000

Source: adapted by the author with reference to Nisbet *et al.* (2009)

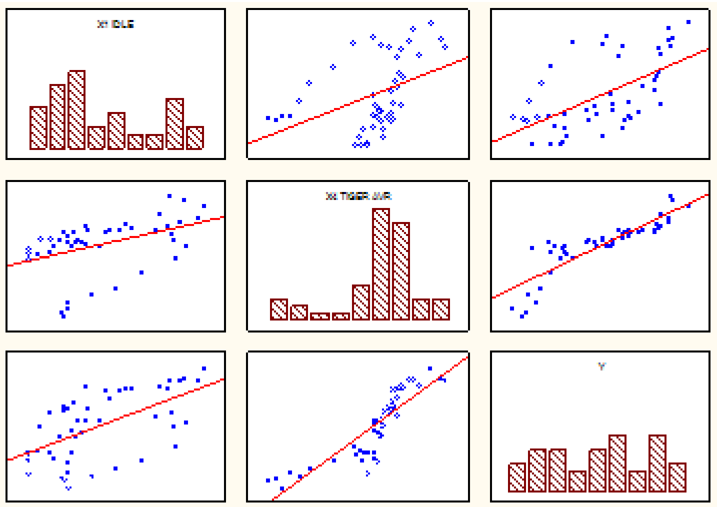

Figure 8. Scatter plot matrix

Source: adapted by the author with reference to Nisbet *et al.* (2009)

A scatter plot displays the correlation between a pair of variables, it's organized into a matrix; making it easy to look at all correlations in one place (see Figure 8).

The Author used the variance inflation factors (VIF) measure to see how much the variance of the estimated coefficients is increased over the case of no correlation among the X variables. If no two X variables are correlated, then all the VIFs will be 1. If VIF for one of the variables is around or greater than 5, there is multicollinearity associated with that variable. The easy solution is: if there are two or more variables that will have a VIF around or greater than 5, one of these variables must be removed from the regression model or some new variable created. As VIF equal to 12,90492 it's necessary to replace two independent variables by the average (see Table 4).

Table 4. The analysis of the 2nd multiple regression model

Parameters		**Results**		
Regression Summary:		$\hat{Y} = 0.263 \times X_1 + 0.756 \times X_4$		
R:		0,90225		
R2:		0,81406		
Adjusted R2:		0,80579		
Standard Error of Estimate:		0,44068		
Results of the ANOVA				
Regression Sum of Squares	**Degrees of freedom**	**Residual Sum of Squares**	**Degrees of freedom**	
ESS=38,26094	df1=3	RSS=8,73906	df2= 44	
F:	F = 98,50842	P-level:	0.00000	
Analysis of the coefficients of the model				
Independent variable	**Coefficient**	**Standard Error of Coefficient**	**t**	**p-level**
X_1	0,26256	0,07139	3,67759	0,00062
X_4	0,75647	0,07139	10,59560	0,00000

Source: adapted by the author with reference to Nisbet *et al.* (2009)

There shouldn't be multicollinearity as the correlation coefficient between variables is low (see Table 5).

Table 5. Correlations coefficients

	X1	**X4**	**Y**
X1	1,00000	**0,43517**	0,59176
X4	**0,43517**	1,00000	0,87073
Y	0,59176	0,87073	1,00000

Source: adapted by the author with reference to Nisbet *et al.* (2009)

Further Durbin-Watson statistics was applied and we can see the positive autocorrelation (because the item equal to 0,61658 is between lower than two) which is quite common in time series data.

To be sure that there is no multicollinearity and that model has good quality one figure was changed in the line 31 from -0,16489 to -0,12489 for the X4 variable. And we can see that we anyway can't accept the hypothesis about model non-significance according to significance level (0.05) as R-Squared equal to 0.81362 and Adjusted R-Squared equal to 0.80533. And if we will look at analysis of the coefficients of the model we could conclude that two of them have p-level lower than our significance level (0.05) (see Table 6).

Table 6. Analysis of the coefficients

Independent variable	Coefficient	Standard Error of Coefficient	t	p-level
X_1	0,26375	0,07143	3,69213	0,00059
X_4	0,75566	0,07143	10,57801	0,00000

Source: adapted by the author with reference to Nisbet *et al.* (2009)

The regression model for sea freight prediction was developed. We see that sea freight on "Shanghai-Riga" shipping route depends on idle containerships capacity in TEU with 3 month retrospective and the influence is defined by 0.263 coefficient and we see that sea freight is more depends on Tracking Index for the Global Economic Recovery and the influence is defined by 0.756 coefficient. It is possible to use this model for prices forecasting that is necessary for every logistic company in the sector to have the geographical flexibility.

This comprehensive view on the specifics of containerised cargoes (alternatives routes with its advantages and disadvantages, main market players, trade lines, price levels and possibility prices forecasting) is necessary for developing competitive transit container freight traffic management schemes from China to the Baltic States.

4. Discussion

The Shipping route „Shanghai-Riga" was analized in the research and comprehensive view on the containerised cargo movements on "China – Baltic States" line has been created. The identification of definitive competitive advantages and disadvantages of this route as opposed to other routes has been accomplished (difference in delivery lead-times, difference in price level for transportations of standard and overweight cargoes).

The liner shipping sector is one of the most dynamic segments of ocean transportation and the prices for sea freight transportation have very significant importance and this is one of main factors that influence the situation in container logistics area on this route. But the most important is to have possibility for forecasting prices in advance. That's why the regression analysis which is a statistical technique for studying linear relationships was applied here.

To have possibility for forecasting prices there were key factors that influence the price level on "Shanghai – Riga port" trade line determined. The independent variable is price for 40'dry container on the route Shanghai port – Riga port, tracking Index for the Global Economic Recovery (TIGER) and idle containerships capacity in TEU with 3 month retrospective were chosen as independent variables.

The regression model allows to see that sea freight on "Shanghai-Riga" shipping route depends on idle containerships capacity in TEU with 3 month retrospective and the influence is defined by 0.263 coefficient and we see that sea freight is more depends on Tracking Index for the Global Economic Recovery and the influence is defined by 0.756 coefficient. It is possible to use this model for prices forecasting that is necessary for every logistic company in the sector.

Since the fiscal crisis of 2008, the growth in container traffic has become less predictable, from a fall of almost 11 % in 2009 to more than 12% in 2010. And now growth is slowing. This is closely related to global economic growth prospects as we see from the research results. The Shipping Line market as well as prices on this market depends on economic situation and has huge impact on the trade volume on the routes.

For Baltic States the maritime logistic sector is very important because they have transit ports for containerised cargoes shipped from China to CIS (Commonwealth of Independent States) countries but in terms of future prospects the Baltic States could lose a lot of transit cargo flows because of strong competition between ports and clear-cut ascendancy of alternative routes. Maritime industry is a very important economic sector and it has a direct impact on the prosperity of the Baltic States that's why the further research should go deeper in the analysis of the factors that influence the specifics of containerized cargo ship movements between sea ports into the system with emphasis on "China – Baltic States". Another avenue of research would be to check the impact of the global financial crisis on the liner shipping network with the stress on "China – Baltic States" shipping line.

Acknowledgement

The article is written with the financial assistance of European Social Fund. Project Nr. 2009/0159/1DP/1.1.2.1.2/09/IPIA/VIAA/006 (The Support in Realisation of the Doctoral Programme "Telematics and Logistics" of the Transport and Telecommunication Institute).

References

Deng, W., Long, G., Wei, L., Xu, C. (2009) *Worldwide marine transportation network: efficiency and container throughput*, (pp. 101-105). China, Chinese Physics Letters

Financial Times. (2013). *Tiger index: Global growth back on track*. Retrieved October 6, 2013, from http://www.ft.com/intl/cms/s/0/8aa7df4e-b6c9-11e1-8c96-00144feabdc0.html#axzz2jZWrkMC

Heaver, T. D. (2010) *The evolving roles of shipping lines in international logistics*, International Journal of Maritime Economics, 4, (pp. 210-235). http://dx.doi.org/10.1057/palgrave.ijme.9100042

Kaluza, P., Kölzsch, A., Gastner, M. T., Blasius, B. (2010). *The complex network of global cargo ship movements.* Vol. 7/2010 (pp. 79-103). J R Soc Interface.

Mikulko, J. (2012) *Ocean Containerised Cargo Shipments: Key Factors Systemization*. Proceedings of the 12th International Conference "Reliability and Statistics in Transportation and Communication" (RelStat'12), 17–20 October 2012, Riga (pp. 179-185).

Nisbet, R., Elder, J., Miner, G. (2009). *Handbook of Statistical Analysis and Data Mining Applications*. London: Academic Press.

Noteboom, T. (2006) *The time factor in liner shipping services, Maritime Economics and Logistics*, 8(1), (pp. 19-39). http://dx.doi.org/10.1057/palgrave.mel.9100148

Rodrigue, J. P., Notteboom, T. (2009) *The future of containerization: perspectives from maritime and inland freight distribution*, Geojournal (pp. 7–22).

Song, D. W., Yeo, K. T. (2004) *A competitive analysis of Chinese container ports using the analytic hierarchy process*, Maritime Economics and Logistics (pp. 34–52). http://dx.doi.org/10.1057/palgrave.mel.9100096

Hu, Y., Zhu, D. (2009) *Empirical analysis of the worldwide maritime transportation network,*), (pp. 71–75).

Slack, B., Fremont, A. (2009) *Fifty years of organisational change in container shipping: Regional shifts and the role of family firms*, Geojournal 74(1), (pp. 23-34). http://dx.doi.org/10.1007/s10708-008-9212-2