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Freight Markets in the Global Container Shipping – Their Dynamics and Its Impact on the Freight Rates Quoting Mechanism

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ABSTRACT: The main subject of research involves the global freight market in the sector of container shipping, and in particular the mechanism for setting up freight rates. The aim of research is to identify and analyse the features and characteristics typical of this market, resulting from the character of market mechanism, as well as to indicate factors which determine market fluctuations and evaluate its impact for the carriers and shippers. Moreover, the causes and effects of fluctuations in effective demand and potential supply in the sector of freight market were identified in terms of their impact on freight rates. The analysis includes three main types of container markets, existing today on a global scale, and characterizes the strategies and modes of behaviour of global container operators undertaking activity on these markets. By applying the theory of mass random service and queueing theory to examine the container freight market mechanisms the method of freight rates short-term forecasting was presented which can be used as an instrument for taking decisions in the sector of global maritime logistics.

1 INTRODUCTION

From the crisis of 2008-2009, the sector of maritime shipping, and in particular its container sector has been in the state of permanent recession. It can be observed in the form of unbalanced market. The potential supply of global container operators, namely the maximum carrying capacity of the container fleet is still by far higher than the effective demand for their services (UNCTAD 2018). It is a result of dynamic growth of world carrying capacity in TEUs based on annual increments, stimulated to great extend by increasing use of mega-container vessels (VLCC), which is much higher than less than expected upswing in demand for container carring services. (see fig. 1.)

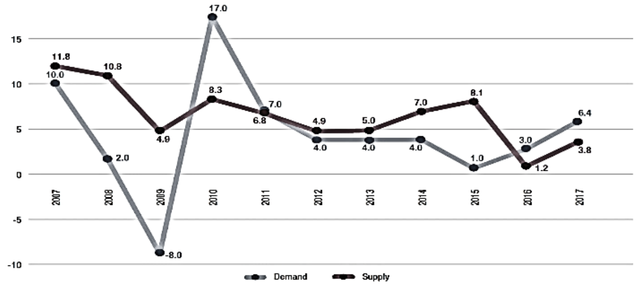

Figure 1. Figure 1. Growth of demand and supply in container shipping, 2007–2017 (Percentage)
Source: (DHL 2018)

This trend can be maintaind for the next few years in the world container shipping. Ocean effective demand fails to rise as predicted between 2011 and 2015 and today it is assumed that the potential demand will equal the potential supply only within 3-4 subsequent years, i.e. in 2020-2021 (see fig. 2).

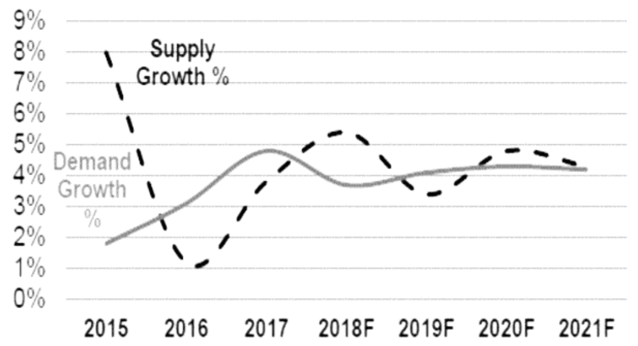

Figure 2. Supply demand growth (annualized), in %. Source: (DHL 2018)

Potential supply growth rate is limited by scrapping the tonnage and delaying the deadlines for the delivery of new vessels ordered in the shipyards worldwide. This peculiar disconnection between the supply and demand side of the container freight market indicates not only the level of impact of global economic situation on the shipping sector, but also its structural weakness, and consequently its market mechanism. In these conditions, the supply side under significant pressure of global competition visible in the network of all transport routes and sub-markets is very susceptible to any forms of subject-ownership consolidation (concentration processes, including mergers, takeovers, and operational integration - alliances). The other, in turn – the demand side is characterised by very high rate of change over time – but first of all, short- and mid-term fluctuations which significantly affect the market situation (. In such circumstances, i.e. related to widening the gap between the supply side, co-determined by the investment based decisions of the carriers and medium-term investment cycle of shipbuilding sector, and the demand side, determined by the decisions of exporters and importers and short-term trading cycle, the market mechanism as effectively operating subsystem controlling the sector fails, in general. The market mechanism, as the instrument not only potentially able to balance this unusually unstable system, but also as the instrument designed to co-develop in an effective manner the allocation-related decisions of carriers and distribution processes – redistribution of benefits (value added) between them and shippers as well as other entities within the global logistic supply chains, fails to perform its function in an effective manner (Grzelakowski 2014).

In such circumstances, the basic functions of freight market become significantly distorted, which result from, and at the same time, result in inefficiency of price mechanism (Carlier et al. 2011). Its distortion is expressed in the detachment of freight and charter rates from the demand-supply relation, i.e. effective demand from potential supply. The analysis of freight market ex post and freight as well as charter indexes, developed for particular segments of the container market and forecasting fluctuations of effective demand, with relatively low price elasticity of the demand, even at short time intervals, fail to provide real grounds for evaluating changes in the level of freight rates based on the evaluation (prediction) of changes in the traditional market parameters – based mainly on macro-economic indicators (increase/decrease of GDP, PMI, trade growth rate, current account balance, level of national debt, etc.). In such circumstances, i.e. with such high level of failure of freight market mechanism, we shall look for other methods and forecasting systems (evaluation) of direction and rate of changes in freight rates in particular segments of the market (Cole 2009, Carlier et al. 2011).

The aim and also the result of research presented in this article is to indicate such method which would help, in a relatively simple and unambiguous manner, with the use of available data base, to define tendencies in shaping freight rates on an annual basis. Since it is important to ensure the reliability of such evaluations related to predicted level of freight rates which should constitute grounds for taking rational decisions by shippers (forwarders/logistic operators) regarding the formula for defining the price in the contract of carriage, i.e. spot or negotiated rates usually for a year (contractual rates). The formula may also be useful in the segment of charters and in the model based on slots (NVOCC). However, it is only indicative in its character and should be applied as auxiliary method. It can be used as an instrument supporting the related decision making processes, based on the traditionally applied heuristic methods, supported by knowledge and experience of the forwarder/logistic operator.

In order to develop this method it was necessary to analyse and evaluate: 1/ model of market mechanism in the segment of global container shipping, 2/ main types of freight markets within maritime shipping, 3/ standard solutions and activities of shipping operators in the condition of crisis. Each element constituting the methodological assumptions developing the structure of presented price formula was synthetically presented in this study.

2 GLOBAL CONTAINER SHIPPING MARKET MECHANISM

The freight market, as one of the types of transport market, has all the features and properties typical of the service market (Cowie 2010. By performing detailed segmentation of the transport market, global freight container markets shall be included into the category of intermodal markets which fall within the group of global logistic markets (OECD 2008). Therefore, by analysing their structure and mechanisms, we indicate that:

1 in their character the markets are secondary markets. They are the markets resulting from prior to them trade markets, and consequently the price elasticity of supply and demand for the services of marine container operators results from the price elasticity of supply and demand for goods carried in containers by sea,

2 price elasticity of supply and demand in the segment of marine container transport is lower than the price elasticity of supply and demand for goods carried in containers by sea. It arises from relatively high rigidity of the supply side of the container transport market – its low reaction to changes in effective demand. It is caused by relatively long investment cycle in the shipbuilding sector (renewal of tonnage) compared to the commercial cycle shaping the demand side (RICS Research 2009),
3 the demand side is characterised by particularly high rate of change over time – high amplitude of changes mainly in short- but also mid- and long-term periods of time (seasonal, business, structural fluctuations). As a result, the adapting processes on the supply side usually occur with significant delay and consequently the container operators are forced to maintain steady tonnage surplus of carrying capacity compared to the average level of demand for their services. It generates additional, usually high fixed costs in this transport sector.
4 freight rates, defined in general as annual tariffs, are not able to reflect significant rate of change in demand and supply parameters of this market. In such situation, they are more indicative and informative in their character, and in the conditions of unbalanced market they are frequently detached from the real system of other market elements (Cole 2009).
5 price rigidity – freight prices defining the level of revenue for container operators, which make the operators apply compensatory mechanisms (numerous freight surcharges, GRI formula, etc.) which only aim to reach at least the break-even-point or the forecasted level of EBITDA, in order to make the relation between the tonnage operating costs and revenue real, in particular during economic downturn.

Such features of marine container freight market unambiguously indicate that to perform its current analysis, and first of all, to forecast the change in particular market elements, we cannot apply the balance model based on pricing, known from the general theory of the market, the so-called Pareto distribution. Since, due to their rigidity, low elasticity and principles to define them, the freight rates are not the component which is able to create the state of balance in this respect. They are practically external components of the market, functioning to a larger extent as instruments creating the financial balance of the carriers, rather than as the creator of market balance – and even the balance perceived in the mid- and long-term time interval (Mallard, Glaister 2008).

In such situation, to analyse the maritime container transport market we need to apply another method, based on the theory of mass random service or queuing theory. With the use of such method we can define in terms of probability (i.e. in real terms, namely in line with the features of this market) the system of applications and system for meeting the demand for transport services of container operators rendering their services on a particular shipping market.

For the market operates as the system of mass random service, with typical flow of applications and distribution in time (week, month, quarter, or year) and the demand-meeting mechanism. It means that each segment of the container market has, at a particular time, its own mechanism of applications and effective demand-meeting mechanism, which is generally random in character and possible to be described only with the use of random variables, namely the theory of probability. Without the knowledge of this mechanism and random parameters we cannot correctly define the principles for defining the freight and charter rates, and evaluate the activities and decisions of carriers and shippers/forwarders based on the typically microeconomic criteria (Kiel et al. 2013.

The mechanism of demand applications for operator's services (alliance, group of operators) in a particular port or ports handled in a particular relation (*loop*), namely the process of applications and its distribution in time can be described with the use of one random variable λ'. Depending on the needs and purpose of the study as well as access to data, the variable can be presented in two variants (Grzelakowski 2014):
1 λ'_1 – presents the stochastic process of applications as per formula: „average" number of applications for particular time per time unit (e.g. 100, 500 or 1000 TEU per month): characterises density of the flow of applications,
2 λ'_2 - presents the stochastic process of applications as per formula: „average" time intervals between the demand subsequent applications (e.g. 2000 TEU on average per week); characterises the intensity of the flow (Daughtey 2008).

The knowledge on random variable λ' makes it possible to determine the distribution of probability of demand applications in formula 1 or 2 and, therefore, defines well the character and type of processes occurring on a particular market from its demand side, i.e. the applications generated by transport markets handled by a particular operator. The information and data should be clearly recognized by the container operator, but also known (examined) by forwarders handling a particular market, since the knowledge on container transport (container shipping) market mechanisms facilitates the decision making in the supply chain, and in particular makes the possibilities of price negotiations real (spot rates versus contractual rates).

However, for the complete characteristics of global maritime container shipping market it is indispensable to know the stochastic processes regarding the demand, namely meeting the demand of shippers/forwarders. The processes are defined by the carrier, indicating the time and conditions of ships voyage/journey. However, due to a number of factors the process is random and therefore its mechanism is also described with the use of random variable λ''. It can reflect, depending on the needs and purpose of analysis (Carlier et al. 2011, Kiel et al. 2013):
1 λ''_1 - „average" within the theory of probability for a particular market (line, loop) number of complete production cycles, e.g. performed voyages (the demand meeting stage) by the carrier within the defined time unit (month, quarter, year), namely the number of calls at a particular port or ports,
2 λ''_2 - „average" (as above) time intervals between subsequent production cycles of ship/ships,

namely subsequent calls at a particular port; it defines the frequency of calls – intensity of shipping operations performed by the carrier taking on the tonnage within particular service (Cole 2009).

Parameter λ'' makes it possible to determine the distribution of demand-meeting flow per particular container operator (alliance) in time, indicating in the majority of cases that the distribution is not – contrary to what can be expected (fixed voyage schedule) – normal but usually exponential. It defines at the same time the average, by stochastic category, time for meeting the demand, and determines the time and cost of such process. These, in turn, constitute crucial parameters defining the efficiency of container freight market in the logistic terms (RICS Research 2009).

Both random variables defining the process of applications and demand-meeting process on the analysed container shipping market make it possible not only to define correctly the mutual relations between the effective demand and potential supply but also to learn better and understand the mechanism of selected container market segment with the related pricing model. It determines their practical value. It can also be used effectively to define the price formula and the tonnage operational productivity which reflects the level of surplus tonnage on the market and determines the level of its operational costs. The costs, in turn, constitute an important factor co-defining the level of freight rates in a short and long period of time.

3 TYPOLOGY OF MARITIME GLOBAL CONTAINER MARKETS AND SHIPPING OPERATORS' PRICING STRATEGIES

The sole knowledge on the mechanism of particular segment of maritime container transport market is the prerequisite but it is insufficient to learn the principles and criteria, based on market premises, related to taking decisions on defining freight rates and introducing changes by container operators. For they are decisions of microeconomic character and are conditional, to a large extent, upon the type of market where particular carriers operate. Therefore, there is a need on the part of operators to analyse their markets in detail in terms of its typology (and previously segmentation). Such analysis is necessary to develop efficient and effective marketing strategy taking account of price parameters. Therefore, the correctly performed market typology increases the knowledge on its mechanisms and the related decisions and behaviour of carriers (Carlier et a. 2011).

In general, we can differentiate 27 types of markets, as economic category. However, in practice, based on the analysis of strength and market reactions regarding the demand and supply side, we can differentiate only nine types of markets, from among which in the analysed segment of global freight market only three types are of significant importance. They include (Grzelakowski 2014):

1 limited monopoly (supply), the so-called competitive monopoly,
2 oligopoly (occasionally referred to as oligopson),
3 bilateral oligopoly i.e. duopoly.

The specified types of markets unambiguously indicate that in the segment of maritime container shipping the oligopolistic market and its various forms occurs as the dominant type of market. It is significantly affected by the production and capital concentration processes (both vertically and horizontally – mergers, takeovers) and the increasing integration in the operational and functional area occurring mainly on the supply side (alliances).

The consolidation of such types of markets proves significant strength and position of container operators able in such conditions to exert effective impact on the behaviours of particular entities – participants in the logistic chain/supply chain (Carlier et al. 2011). Moreover, in the conditions of increasing concentration of maritime transport sector, their market position is increasing as well as their bargaining power towards the demand side of the market, i.e. shippers (exporters and importers). As a result, they begin to function as the supply chain operators within the whole segment of transport (not only maritime transport). By taking the leading role in the area of supply chain management, they gradually introduce their own pricing solutions, based on their strategies, which we could have been observed recently in extending the range of freight surcharges and the introduction and overuse of GRI (*General Rate Increase*) mechanism (Carlier et al. 2011).

In the current market situation, the pricing strategies of global container operators are based on two basic criteria (Daughtey 2008):

1 achieving the economic optimum within the operational and commercial area, which the oligopolists can reach when their final short-term cost equals the final revenue; it is actually their economic (but not financial) point of production profitability, namely the equivalent of break-even-point of operators undertaking activity on the oligopolistic market,
2 achieving the technical optimum (technological) of production, perceived in the category of higher use of tonnage capacity, which the carriers can reach when their final short-term cost equals the average total cost of transport services (constants and variables). Within such optimum – level of production, the final cost of transport of each subsequent unit is already much higher than the final revenue obtained by the carrier, and consequently the production profitability is steadily decreasing (Grzelakowski 2014).

Depending on the type of market where the container operators provide their services, the point of economic and technological optimum and its production will be shaped differently in terms of using the carrying potential. And, in the conditions of duopoly, the economic optimum is usually reached already with the use of min. 55% of carrying potential, whereas on the oligopolistic market the limit amounts to ca. 62-65%, and the competitive monopoly only above 70% (higher economies of scale resulting from the reduction in fixed costs). In the case of technological optimum, the limit is shifted along the axis of production, i.e. the level of using max. carrying capacity (potential supply). At duopoly, it amounts to ca. 65%, oligopoly ca. 75 %, and limited monopoly 83 – 88 % (Grzelakowski 2014).

In practice, the indicators define the potential areas and forms of the container operator pricing reaction - oligopolists operating on such market characterized by the established distribution of applications and effective demand meeting system. The lack of possibility to reach the economic optimum, e.g. due to limitations from the demand side – lack of dense flow of applications with significant supply surplus at the same time, will make operators turn towards the technological optimum. It is more oriented to minimize the tonnage operational costs, and strive to maintain the existing level of freight rates and eliminate pressure to reduce them. In such case, the operator's area of activity is included between the economic and technical optimum of production – actually it is shifted from the first towards the second one. Such activities are usually accompanied by the pricing strategy, characteristic of such system, expressed in gradual departure from the tendency to maximize the service production profitability, i.e. surplus of final revenue over the final costs of production towards the tendency to minimize the costs and strive to maintain the previous or possibly stable level of revenue (minimal profitability of production).

The change in distributing the flow of effective demand and meeting the demand, expressed in the form of increasing intensity of applications and parallel reduction of surplus supply, will generate, in turn, another type of pricing strategy within this type of market. The process related to gradual departure from the approach oriented to the technical optimum of production towards the economic optimum will be accompanied by constant pressure to increase the freight rates and improve the production profitability ratio per unit. It indicates the attempts of operators to maximize the marginal revenue and minimize the marginal short-term costs.

4 FREIGHT RATES SHORT-TERM FORECASTING IN THE SEGMENT OF CONTAINER SHIPPING – RATE ESTIMATION METHOD

The knowledge of container market mechanisms and behaviour of operators undertaking activity on particular markets may facilitate, to a large extent, the correct assessment of change in the level of freight rates within a few or several months. Therefore, taking account of indicated parameters, crucial for the correct assessment of the market regarding both areas of analysis, i.e. mechanisms and typology of maritime container markets, we can define factors (variables) which can constitute grounds for estimating the scale of change in the level of freight rates within a few or several subsequent months at the most. They include the following variables (indicators):

1 V - surplus/shortage of tonnage of operator/operators on a particular line, which determines the level of tonnage operational productivity (TEU/dwt) and indirectly indicates how the tonnage operational costs are shaped and how the selected components of costs can change in relation to this parameter in the nearest future. The variable directly reflects the standing of the market where the container operators undertake their activity,

2 Y - forecasted increase/decrease in effective demand for carriers' services operating within a particular relation, estimated under official, published statistical data related to commodity exchange, and commodity freight and exchange indexes,

3 Z – predicted changes in the level of ship's operational costs (their increase or decrease), triggered, however, not by the factors of freight market where the shipping operator undertakes their activity, but by other types of markets (e.g. energy markets, labour markets, capital markets, other service markets).

Taking into account the said variables we can determine the function of change in price level in the form of:

$$X_{t+n} = X_t \ \mathrm{x}\ V^{e1}{}_{t+n} \ \mathrm{x}\ Y^{e2}{}_{t+n} \ \mathrm{x}\ Z^{e3}{}_{t+n},$$

where:
$\mathbf{X}_{t+n}$ - estimated level of rate in time t + n,
$\mathbf{X}_{t}$ - freight rate in time t,
$\mathbf{V}_{t}$ - surplus/shortage of tonnage (correlation between potential supply/effective demand) in time t + n [elasticity coefficient e1 defining the tendencies of changes in time t + n],
$\mathbf{Y}^{e2}{}_{t}$ - increase/decrease in effective demand – predicted changes in time t + n expressed in the estimated elasticity coefficient e2,
$\mathbf{Z}^{e3}{}_{t}$ - changes in the level of tonnage operational costs in time t + n defined by elasticity coefficient e3.

These factors, to different degree and different strength may affect the decisions of the carrier related to quoting freight rates – their changes in time. Each of them should be monitored and analysed carefully and individually „balanced" by the forwarder/logistic operator in terms of forecasting (estimating) changes in freight rates. Since the importance of each of these parameters may develop differently in different time intervals (increase in some of them, decrease or stabilization of the other). Therefore, the significant variability of these parameters in time and different direction of changes require due caution when balancing each of them, i.e. assigning a particular elasticity coefficient to each parameter. The decision should not only be preceded by thorough analysis of the market, but also supported by evaluating the activities taken by carriers and shippers on other container transport markets but of similar profile of the flow of applications (Carlier et al. 2011, RIOS Research 2009).

Detailed analysis of the process of shaping freight rates at the selected types of markets (ex post) indicates that the elasticity coefficients which can be „assigned" to any of these factors – variables fall within the following ranges:

1 V – [0,65 – 1,30]; lower limit of indicator denotes the ultimately high surplus of carrying potential located on a particular market, upper limit – ultimate shortage of tonnage relative to the effective and potential demand (t + n),

2 Y - [0,85 – 1, 25]; lower limit of indicator denotes ultimately pessimistic forecast related to the economic growth and increase in commodity exchange, and the upper limit – ultimately optimistic forecast,

3 Z - [0,90 – 1,35]; lower limit of indicator includes optimistically estimated tendencies regarding the decrease in tonnage operational costs (e.g. significant decrease in bunker prices), and the upper limit – definitely pessimistic estimates – significant growth rate of operational costs and among them mainly the cost of the bunker (UNCTAD 2018, IHS Market 2018). The dynamics of changes in bunker cost over the last two years are shown in Figures 3 and 4.

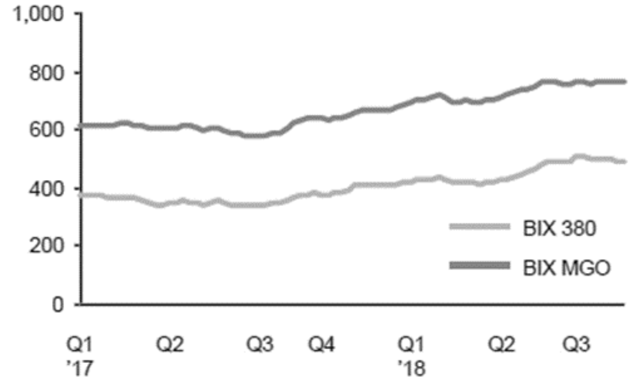

Figure 3. Bunker price index (Q to Q 2017-2018)
Source: (DHL 2018)

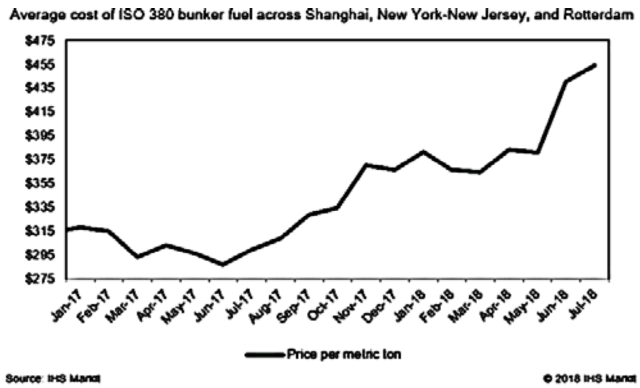

Figure 4. Average cost of ISO bunker fu 2018el in the leading Asian, US and European ports (Jan.2017- July 2018)
Source: (IHS Markt 2018, UNCTAD 2018)

In order to estimate correctly the level of freight in time t + n we need to include all dependent variables, assessing them through the economic situation in particular regions in the world managed by particular container service.

5 CONCLUSIONS

The presented model – formula for estimating the level of change in freight rates in the segment of container shipping is only indicative in its character. It shows from ex post perspective the character and type of correlations within the process of predicting freight rates on a particular type of container market (oligopolistic) with proper application and demand-meeting mechanism. The grounds for this study included data obtained from selected, real segments of maritime container shipping market (UNCTAD 2018). The model was also partially (ca. 57 % relative to the output data base). The obtained correlation indicators fell within the range between 0.63 and 0.76 (Grzelakowski 2014). However, such high concurrence does not mean that the function is a universal instrument for predicting the levels of freight rates since the intensity of change occurring within each of the parameters defining the demanded variable ex ante may be so significant so that it would require changing the elasticity range within each of the parameters or adding another variable defining parameter X (e.g. EBITDA). However, according to the author the model provides sufficient and solid grounds for estimating the direction and rate of change in freight rates within 12 - 18 months.

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