APPLICATION OF RISK FACTORS EVALUATION METHOD FOR ASSESSMENT OF VOYAGE EFFICIENCY IN TRAMP SHIPPING

Sen. Assistant Prof. Varbanova A. PhD
Faculty of Shipbuilding, Technical University – Varna, Bulgaria

anneta_varbanova@hotmail.com

Abstract: *The present article outlines the risk factors affecting voyage efficiency in tramp shipping operations. The influence of factors of time and costs parameters is identified. The voyage revenue is formulated and studied according to variances of time and costs elements. For the evaluation of efficiency of voyage operations an approach based on value-at-risk method is proposed and voyage statistics in short sea shipping are studied. The results presented prove the applicability of the method for efficiency evaluation of tramp shipping operations and voyage planning.*

Keywords: TRAMP SHIPPING, RISK FACTORS, VOYAGE EFFICIENCY, RISK ASSESSMENT

1. Introduction

Maritime transportation demand is derived demand as it depends mainly on the demand for certain commodities or products. Considering that the fee for transportation by sea is represented by freight rates (in general) same are affected both market factors (ration between supply and demand in the freight market) as well as the costs structure of transport activities. Tramp shipping is considered as highly risky business activity as freight rates and prices of bunker are characterized by volatility against the increasing costs for shipowners and maritime operators. The revenue and profit of shipowners and maritime operators are influenced by a number of factors that pertain to the external (market) parameters and internal (cost) parameters. The said uncertainty of tramp shipping operations can be attributed to the state of the freight markets, economic activity for a certain group of commodities, political events and economic cycle. The market risk for shipowners and operators is an object of analysis and measurement in view of its potential impact on revenues and profits. The purpose of the present article is to study in detail the main risk factors affecting voyage efficiency in tramp shipping. The income and costs structure of voyage implementation is presented along with details of each element thereof. Consequently, the risk factors for efficient voyage implementation are identified as cost and time parameters which value depends on the duration of the voyage and market prices of bunker fuel. The value-at-risk (VaR) approach is applied to evaluate the expected losses due to a prolonged voyage and/or increase of bunker prices. The results show that the proposed method serves as an applicable tool in controlling and evaluating the voyage efficiency in tramp shipping.

2. Voyage efficiency in tramp shipping and risk factors

Tramp shipping is generally characterized by volatile demand. Being an industry of high commercial risk, shipowners and maritime operators strive to apply new approached for evaluation of transportation efficiency. There are several studies for assessment of the market risks effect on voyage efficiency [4]. However, a few are focusing on voyage efficiency from an operational point of view. Policy implications for risk averse shipowners with a choice of employing ships between the spot and time charter markets, point to preferring the lower risk time charter market over the spot market in general [2].

The objective of this article is to develop a conceptual model for analyzing the effect of the market risks on the results of vessels' operations and to quantify the deviation of planned results versus actual results in voyage operations. As a first stage the most important market risks are identified and their impact on the voyage results. The system approach allows for structuring a conceptual model for evaluation of voyage efficiency under the effect of market risks (Figure 1). The empirical analysis concerns the actual performance of voyages thus all the commercial factors are constants including freight rate, loading and discharging rates at ports, commissions and the cargo quantity margins. According to the established practice all elements of the voyage implementation are planned in advance via voyage estimating. Due to the latter we can assume with a high level of probability that the expected result will be close to the planned. The latter refers to the time and costs parameters as well. The time components (parameters) include: steaming time between ports (laden and ballast legs), port stay time (cargo handling operations and unplanned delays) as well as unplanned delays during the passages between ports.

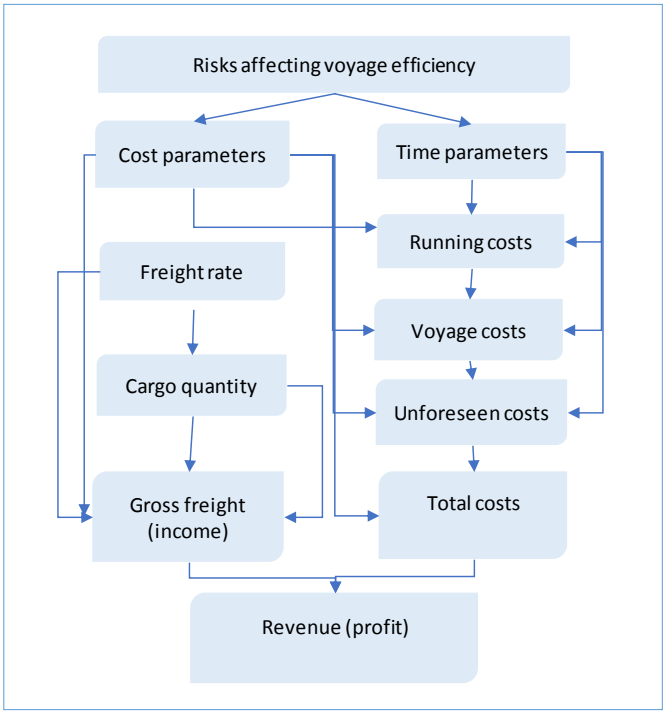

Figure 1*. Conceptual model for evaluation of risk factor impact on voyage efficiency*

The time components can be formalized as follows:

$$T_v = T_S + T_p + T_u \quad (1)$$

Where T_v represents the total voyage duration (number of days), T_s the steaming time both vessel being laden and in ballast, T_p represents the duration of time in port (number of days) and Tu is the duration of unforeseen delays (number of days).

The costs components (parameters) include the costs of disbursement accounts in ports, bunker costs, costs for passing canals as well as the running costs of the vessel. The costs for

bunkers, disbursements and costs related to cargo operations (in case same are for owners account) form the variable (voyage costs). The voyage implementation is also related to running costs, i.e. all costs that are incurred regardless of vessel's employment during the operational period. The level of voyage costs will depend mainly on the fuel prices, the current level of disbursement accounts in ports, etc. Running costs are also affected by the duration of all time components of the voyage as well as by the set budget of daily running costs. As voyage (variable) costs are mainly determined by time and costs parameters of the voyage depending on the bunker prices, disbursements and canal tolls. Thus we can assume that the most important parameters in evaluation of vessels' efficiency are the cost and time values given the agreed value of gross freight income. Therefore we can define the total costs of the voyage as follows:

$$T_v = VC + FC \quad (2)$$

The gross income basis the agreed freight is based on the total quantity loaded multiplied by the freight rate plus the due demurrage (if any).

$$R = Q.f + dm \quad (3)$$

where R represents the gross voyage revenue, Q is the Bill of Lading weight of the cargo, f – freight rate and dm – the gross amount of demurrage due to the owners.

The net voyage revenue can be represented as follows

$$R_n = (Q.f + dm) - \frac{(Q.f + dm) * K}{100} - ds \quad (4)$$

where R_n is the net voyage revenue, K – total amount of commissions agreed and ds – the amount of dispatch (if any). Commissions are due on gross freight, deadfreight and demurrage.

As an efficiency indicator the voyage revenue is used that can be presented as the difference between the net voyage revenue and total voyage (variable costs):

$$R_v = \left[(Q.f + dm) - \frac{(Q.f+dm)*K}{100} - ds\right] - VC_v \quad (5)$$

where R_v is the voyage gross profit and VC_v are the variable (voyage costs) of the voyage.

On the basis of the net result of the voyage the daily financial results can be derived as follows:

$$TCE = \frac{\left[\left[(Q.f+dm) - \frac{(Q.f+dm)*K}{100} - ds\right] - VC_v\right]}{T_v} \quad (6)$$

where *TCE* is the timecharter equivalent for the voyage.

The timecharter equivalent characterizes the profitability per day for a specific voyage and a specific ship. This indicator allows to perform comparison between different options of voyage employment of ships. As a rule, the planned timecharter equivalent should be higher than the rate of the daily running costs thus ensuring for a certain percentage of profit taking into account the pertaining risks during the voyage implementation.

The actual circumstance for implementation of the voyage as well as the risk factors may lead to the change of the time and cost parameters and thus to a change of the planned profit level. In practice, the planned result differs from actual result in a negative interrelationship, i.e. voyage revenue is lower than planned. Tramp shipping operations are affected by a number of external factors and risks [4]:

- change of bunker prices

Bunker prices are closely related to the state of the freight market. In the case of high market conditions the freight rates increase more slowly than the bunker prices. Conversely, the freight rates decrease sharply following the decrease of bunker prices which shows a lower state of the freight market. Figure 2 presents the dynamics of bunker prices (IFO 380 cst) at Bosporus for the period November, 2017 to April, 2018. As evident, the bunker prices can vary by more than 25% within a month only;

- delays in ports of loading and discharging

These refer to issues of discrepancies regarding cargo delivery in port, lack of cargo documents preventing customs clearance, etc. The latter can directly affect the port stay time and thus the overall duration of the voyage. Also these factors include the delays due to servicing of the ships in ports (activities of ship agents, pilots, tug companies, port authorities, etc.);

- change of port disbursements

These refer to the local price policy of port tariffs, most valid for larger ships performing longer voyages due to the longer time span between sailing from load port until arrival at discharge port. This factor affects the cost parameter in terms of voyage costs;

- weather conditions during the voyage

These factors refer to the weather conditions during sailing time and during port stay time. These may affect the safety condition of the ship and thus incur additional costs and time loss for unplanned repairs and/or supplies;

– human error

These refer to omissions of the crew that can affect negatively the operation of the ship and lead to loss of time due to incidents and delays. On the part of shore personal, with reference to the ship management activities, human errors can be related to improper and untimely decisions to/not to supply the ship or to decisions leading to loss of time due to unavailability of cargo, cargo documents, delayed formalities at ports, etc.

Factors described above can affect the time parameters of the voyage in terms of increase of steaming and port stay time.

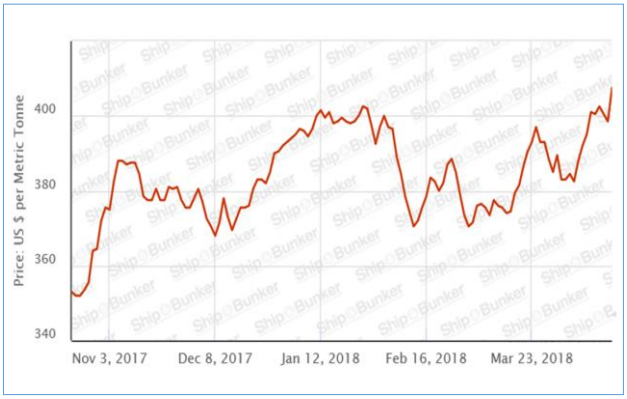

Figure 2. *IFO 380 cst prices for bunker supplied at Istanbul [6]*

As a result of the costs change (increase of bunker prices and/or port disbursements) and time parameters (increase of steaming time and port stay time) the voyage costs increase. It should be noted, however, that apart from the bunker prices and port disbursements, the weather delays are considered extreme external factors that are not liable to initial evaluation. The increase of voyage duration leads to increase of the running costs. The increase of running costs is often related to crew errors, ship management errors and delays of ships in ports. Therefore, when a voyage is planned, the entire system of affecting factors must be taken into account in order to evaluate correctly the expected voyage efficiency. Moreover, the decrease of daily revenue is due not only to the cost increase but also to the decrease of daily income.

Bunker consumption is planned in advance according to empirical evidence from ship's operation and to the technical specification of ship's engine. They are set separately for the sailing

period and for the port stay. It should be noted that the relationship between speed and bunker consumption is not linear therefore careful considerations should be made for the trade-off between time saved and bunker costs saved as concerns speed management.

Bunker costs will increase due to the increase of sailing time or time in port as well as due to the increase of bunker prices. As concerns disbursement accounts some of their elements are dependent on the duration of port stay – for example berth dues, anchorage dues, agency fee, etc.

3. Evaluation of risk factors impact on voyage efficiency

For the purposes of risk factor evaluation, we assume the commercial elements of the voyage, i.e. the charter party terms, are constant. The latter refers to the cargo quantity, freight rate and agreed brokerage. The margin of voyage elements values has been ascertained via statistical study of voyage implementation of a 5300 mts DWAT general cargo vessel performing contract voyages between Constanta and Ravenna for the period April, 2017 to April, 2018 (Table 1).

Table 1. *Characteristics of 5000 mts DWAT general cargo vessel*

Vessel type	general cargo
DWCC (bulk grain cargo)	5000 mt
Freight rate [7]	36 $ per mt (net)
Service speed (average)	10 knots
Voyage rotation	Constanta – Ravenna
Distance (nm)	1312 nm
Total sailing time (incl. ballast)	10,93 days
Total time in port	5 days
Bosporus passage (one way)	1 day
Total voyage duration	16,93 days
Price of IFO 380 cst [6]	430 $/mt
Price of MGO [6]	670 $/mt
Total D/As and canal fees	26000$
Daily running costs	3500$/day

Models for estimation of market risks are of the purpose to predict potential losses as an outcome of external factors changes. One of the best-known and most widely used of risk measurement tools is value at risk (VaR) [5]. The findings of the present study can be applied in vessel's operations for short sea shipping in the Black Sea and the Mediterranean region particularly for the financial risk management in shipping.

A main concern for the market risk manager is the choice of the most appropriate market risk measurement method amongst a number of alternative models developed in the literature [3]. Value-at-risk method (VaR) is the maximum amount of loss that can be sustained with a given probability over a certain period of days. It is typically calculated within a 95% or 99% confidence interval. VaR is defined as the dollar (or percentage) loss to be exceeded with a certain probability (known as confidence level) over a given time horizon [1]. For the purposes of this study we strive to understand the overall risk factors structure for tramp shipping. The values of VaR measures are calculated for above mentioned period. The realized α-level VaR measures are computed as the 1-α quantiles of the past n observations of X_t, as in the following equation [5]:

$$\mathrm{VaR}(\alpha) = \mathrm{Quantile}^{1-\alpha}(\{X_t\}_{t=1}^{n}) \quad (7)$$

VaR method is based on the determining of certain deviations (losses) at given probability. In order that the application of this method is correct it is necessary that the studies values of the cost and time parameters are random values with normal distribution. For the purposes of the latter we have conducted statistical study of the bunker prices and duration of port stay for a sequence of voyages performed by a general cargo vessel as described in Section 2 of the present article. Figure 3 presents the hypothesis test of the random value distribution type as concerns port stay in ports – as evident it is subject to normal distribution. The Pearson's test confirmed the on-contradiction to the initially adopted hypothesis of normal distribution with □ 2 with value 4,0655 and p with value 0,0678 which is acceptable for such analysis.

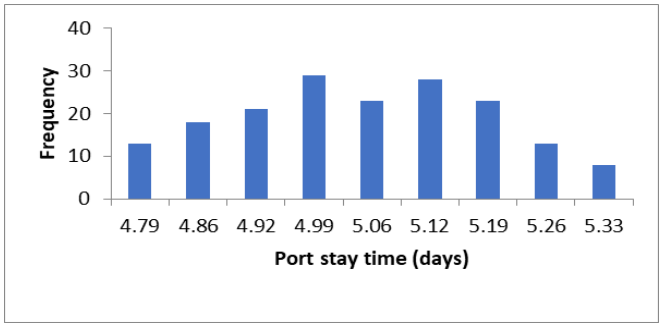

Figure 3. *Statistical analysis of port stat time (number of days)*

As a result it has been ascertained that the mean value of port stay time is T_p = 5.06 days that can be assumed as planned value. In accordance with (7) we have calculated with 99% and 95% probability the potential losses on case of deviation of the port stay time from the mean value. The results are presented in Table 2.

Table 2. *Voyage VaR for a 5300 DWAT general cargo vessel (Contanta-Ravenna) for increase of port stay time*

Increase of days in port	99% VaR	95% VaR	Total costs per voyage (USD)	Profit/Loss per voyage (USD)
4%	0.196	0.112	$ 174,084	$ 5,916
8%	0.201	0.115	$ 178,557	$ 1,443
12%	0.206	0.118	$ 183,059	$ - 3,059
16%	0.211	0.121	$ 187,589	$ - 7,589
20%	0.216	0.123	$ 192,146	$ - 12,146
24%	0.222	0.126	$ 196,732	$ - 16,732
28%	0.227	0.129	$ 201,346	$ - 21,346
32%	0.232	0.132	$ 205,987	$ - 25,987
36%	0.237	0.135	$ 210,657	$ - 30,657
40%	0.243	0.138	$ 215,355	$ - 35,355

It should be noted that the assumed losses in terms of increase total costs of the voyage will lead to incurring of loss for the implementation of the voyage. The latter is a direct result of the increased port stay time. Vessel operators are able to evaluate efficiently the direct impact of delays of port stay and plan in advance.

The evaluation of VaR in case of changes of MGO bunker prices for the presented voyage rotation are presented in Table 3. As in this case MGO consumption is limited only to port stay time the sensitivity of this factor is low as compared to the time parameter of prolonged port stay time. Planning of bunker supply is also considered as important element of vessel operations and therefore should be planned well in advance taking into account both the price of bunker, additional costs for bunkering and time loss thereof. It should be also noted that bunker prices can be extremely volatile within a short period of time and there is a large variance of

prices between different ports/regions, even for the same standard type of bunker fuels.

***Table 3**. Voyage VaR for a 5300 DWAT general cargo vessel (Contanta-Ravenna) for increase of MGO price*

Increase of MGO price	99% VaR	95% VaR	Total costs per voyage (USD)	Profit/Loss per voyage (USD)
3%	0.195	0.111	$ 172,900.67	$ 7,099.33
6%	0.198	0.113	$ 176,163.33	$ 3,836.67
9%	0.202	0.115	$ 179,426.00	$ 574.00
12%	0.206	0.117	$ 182,688.67	$ - 2,688.67
15%	0.209	0.119	$ 185,951.33	$ - 5,951.33
18%	0.213	0.122	$ 189,214.00	$ -9,214.00
21%	0.217	0.124	$ 192,476.67	$ - 12,476.67
24%	0.221	0.126	$ 195,739.33	$ - 15,739.33
27%	0.224	0.128	$ 199,002.00	$ - 19,002.00
30%	0.228	0.130	$ 202,264.67	$ - 22,264.67

The proposed VaR method allows for realistic conclusions about the expected deviations of the cost and time parameters for certain voyages implementation given the expected variations in MGO prices and port stay time duration. It should be noted that this method, although being straightforward, has certain drawbacks as larger losses (beyond the ones computed) are being ignored. Nevertheless, the application of the VaR method in voyage planning and operations, especially for shorter sailing distances, is a valuable tool for assessment of voyage efficiency.

4. Conclusion

Tramp shipping market, being highly volatile, required metrification of risk and evaluation of vessel operation methods. The present paper has analyzed the applicability of the VaR method for evaluation of voyage efficiency in tramp shipping. The findings have proved that time and cost parameters of the planned voyage and their variations can lead to significant loss in voyage revenue and profit. We have ascertained the system of risk factors that affect the voyage results such as prolonged port stay time, changes in bunker prices, human errors in ship management, weather conditions, omissions in vessel's servicing in ports, delays of cargo delivery in ports, etc. It has been proved that the abovementioned factors can affect directly the cost and time parameters of the voyage. The deviations of the latter lead directly to deviations between planned and actual result of the voyage. The analysis has been conducted on the basis of empirical study of data for actual voyages on the Black Sea and the Mediterranean region for a short sea shipping transportation. The total costs of the voyage and the profit/loss have been calculated. For the purposes of evaluation of the probable deviations of the port stay time and MGO process we have applied the VaR method in order to determine the maximum level of deviation of port stay time and MGO process at a given probability. For the purposes of the correctness of the study statistical analysis has been carried and its results proved the applicability of the VaR method for the evaluation of voyage efficiency. The results can be further used for evaluation of vessel operation activities based on the probabilistic nature of the cost and time parameters as part of the vessel's voyage on the basis of the proposed method for evaluation of vessel's voyage efficiency.

5. References

[1]. Angelidis, T., Skiadopoulos, G., 2008, Measuring the market risk of freight rates: a value-at risk approach, International Journal of Theoretical and Applied Finance, Vol. 11, No. 5, pp. 447–469

[2]. Kavussanos, M.G., 2003, Time varying risks among segments of the tanker freight markets, Maritime Economics and Logistics, Vol. 5, No. 3, pp. 227–250

[3]. Kavussanos, M.G., D. Dimitrakopoulos, 2011, Market risk model selection and medium-term risk with limited data: application to ocean tanker freight markets, International Review of Financial Analysis, Vol. 20, No. 5, pp. 258–268

[4]. Onyschenko, S., Vyshnevskaya O., Evaluation methods for voyage results deviation under risk factors, 2016, NTU Annals, 7(1179), pp. 25-31

[5]. Unal, G. et al, Revealing the freight market risk in Istfix shipping area, 2014, International Journal of Shipping and Transport Logistics, 6 (6), pp. 593-610

[6]. https://shipandbunker.com

[7]. https://metalexpert.com