Представлена у загальному виді модель оцінки ризику виходу експедитора на ринок транспортних послуг. Наведений алгоритм імітаційного експерименту для оцінки впливу параметрів попиту на ризики експедиторів. Описані результати експериментальних досліджень. Запропонована регресійна модель для оцінки ризику, отримана на підставі результатів імітаційного експерименту

Ключові слова: ризики експедитора, транспортний ринок, алгоритм імітаційного експерименту, програмна реалізація

Представлена в общем виде модель оценки риска выхода экспедитора на рынок транспортных услуг. Приведен алгоритм имитационного эксперимента для оценки влияния параметров спроса на риски экспедиторов. Описаны результаты экспериментальных исследований. Предложена регрессионная модель для оценки риска, полученная на основании результатов имитационного эксперимента

Ключевые слова: риски экспедитора, транспортный рынок, алгоритм имитационного эксперимента, программная реализация

UDC 656.96
DOI: 10.15587/1729-4061.2015.47699

EVALUATION OF FREIGHT FORWARDER RISK TO TRANSPORTATION MARKET ENTRY

V. Naumov
Doctor of technical sciences, professor
Transportation Technologies Chair
Kharkiv national automobile and highway university
Petrovskogo str., 25, Kharkiv, Ukraine, 61002
E-mail: naumov.vs@gmail.com

1. Introduction

Functioning of transportation market participants is characterized by the presence of uncertainty and conflicts, by volatility of goals, which is caused by influence of huge number of stochastic factors on technological processes and by struggle of participants for scarce financial and material resources. It leads to appearance of so called risk situations in the processes of making decisions by freight forwarders, carriers, 3PL-providers (freight terminals) and shippers. Consideration of risks in managing freight forwarding processes allows decreasing potential losses as the result of market situation change for logistics system elements, which are involved in delivery process. Also risks evaluation could be used for estimation of feasibility of certain administrative decisions.

According to [1], risk could be defined as economic category, which reflects for the interested entities the peculiarities of their perception of objectively existing uncertainty and conflict. Uncertainty and conflict situations in freight forwarding management occur in making the decisions in certain situations of transportation market participants' interaction.

2. Analysis of published data and problem statement

Freight forwarders risks in contemporary literature, as a rule, are defined for situations of traffic conditions or driver's risk tolerance (human factor is being considered) and are related to the features of insurance procedures.

In the paper [2] its authors complete a theoretical analysis of advanced traveler information systems for road choice with risk-averse drivers who rationally learn over time, in a simple setting. For this purpose, they have studied the one-armed bandit problem, where a driver selects, day after day, either a safe or a random road. Numerical example, provided by authors, illustrates the impact of risk aversion on dynamic optimal strategies.

Authors of [3] analyze the decisions of drivers on whether to acquire information and which routes to take on simple congested road networks. Drivers in the paper are varied in their degrees of risk aversion with respect to travel time. Obtained by authors results show, that free or costly information can decrease the expected utility of drivers who are very risk averse. It's also been concluded that with sufficient risk aversion in the population, the aggregate compensating variation for information could be negative.

In paper [4] authors consider a multiproduct two-echelon production-inventory-distribution system design model that captures risk-pooling effects by consolidating the safety-stock inventory of the retailers at distribution centers. They propose a model that determines plant and distribution centers locations, shipment levels from plants to the distribution centers, safety-stock levels at distribution centers, and the assignment of retailers to distribution centers by minimizing the sum of fixed facility location costs, transportation costs, and safety-stock costs. The model is formulated as a nonlinear mixed-integer programming problem and could be used for evaluation of participants' risks. The proposed approach could be characterized as an example of mathematical model for determination of risks.

The article [5] focuses on the most important risks in the context of international freight forwarding operations, highlighting some of the critical areas that an international freight forwarder should be mindful of, and offering suggestions for managing these risks. The author notes that, due to the wide variety of services that an international freight forwarder may offer, it is not possible to deal with all circumstances, therefore, only the major risk aspects should be considered. In his further paper [6], R. Bergami outlines that, properly used, Incoterms 2010 are an effective risk management tool. He claims that old trading practices create tension with modern transport practices and Incoterms 2010, potentially increasing risks for traders (but not for transport companies). The article [6] considers the impact of outdated trade and banking practices and their likely impact on traders, concluding that an enterprise risk management approach is required, incorporating specific staff training, to modernize trade practices and reduce organizational risk.

As it could be concluded, existing approaches to freight forwarders risks estimation are not based on technological process model. They take into consideration external factors, such as legal framework, traffic conditions, logistics system structure and others. In [7] the mathematical model was proposed, which allows determining of expediency for freight forwarder functioning at the transportation market. This model considers features of freight forwarding technological process. In this research that model is taken as a base for estimation of freight forwarder risk to transportation market entry.

freight forwarder's income from request service does not exceed expenses on its service.

For numeric evaluation of freight forwarder risk to entry the market, the statistical data on values of forwarding enterprise income and expenses (or – its profit) related to the process of requests servicing are required. On the base of these statistical data the probability could be determined according to (1). Among the factors that determine the probability of occurrence of an event $I_{FF} \le E_{FF}$, there should be highlighted: time intervals of requests on freight forwarding services and tariff on services of the freight forwarder, which unequivocally determines an income of the enterprise.

To provide the experimental studies for determination of dependence of freight forwarder risk to entry the market from parameters of demand (requests interval) and enterprise's pricing policy (freight forwarder tariff on the complex of services), a simulation model of servicing by the forwarding company of requests flow has been developed. The simulation model is implemented with the use of base classes described in [8]; its algorithm is presented at Fig. 1.

3. Purpose and objectives of the study

The research aims to develop the method for evaluation of freight forwarder risk to entry the transportation market (or the certain market segment).

To achieve the research aim, the following research objectives should be implemented:

1. To develop the simulation model for risks evaluation and its software implementation.

2. To conduct the simulation experiment using developed simulation model.

3. To analyze results of the conducted experiment.

4. Simulation model for evaluation on freight forwarders risk to entry the transportation market

Risk of freight forwarder entry on transportation market belongs to the group of risks, which are defined as a probability of event occurrence. According to [9], risk could be defined as a probability (threat) of loss by a person or organization of a part of its resources, of non-receipt of its income or of appearance of additional costs as a result of certain operating or financial policies. For the situation of freight forwarding enterprise entry to the transportation market (or its certain segment), risk of freight forwarder is a probability of failure of a condition $I_{FF} > E_{FF}$ [7], where I_{FF} – freight forwarder's income, E_{FF} – freight forwarder's expenses, i.e. a measure of risk r in this case could be determined as a probability of an opposite event occurrence:

$$r = 1 - p(I_{FF} > E_{FF}) = p(I_{FF} \le E_{FF}), \qquad (1)$$

where $p(I_{FF} > E_{FF})$ – probability of an event, that freight forwarder's income from request service will exceed expenses on its service; $p(I_{FF} \le E_{FF})$ – probability of an event, that

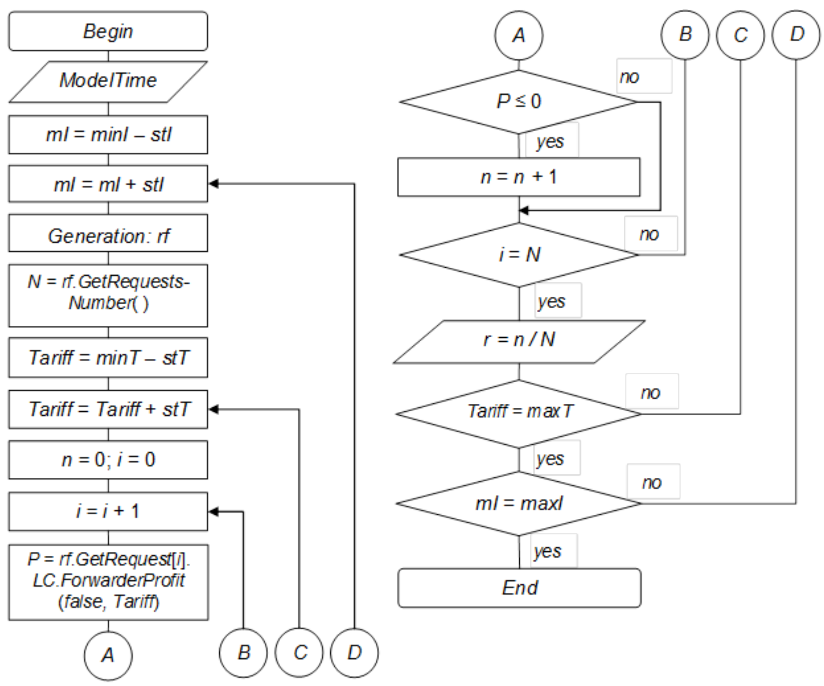

Fig. 1. The simulation experiment algorithm for determination of freight forwarder risk to entry the transportation market

As an input parameter for the algorithm of simulation experiment at Fig. 1 a model time for the requests flow is considered. At the base of this index a generation of an *rf* object of *RequestFlow* type is provided; this object represents a list of requests ordered by their appearance time [10]. Values of requests intervals in a flow are generated with the use of a scale parameter – mathematical expectation *mI*. For each of values *mI* considered in the simulation experiment (in the range from *minI* to *maxI* with the step *stI*), generation of requests flow is implemented, wherein number *N* of requests in a flow is determined with the help of *GetRequestsNumber*( ) method of *RequestFlow* class [8]. For the obtained requests flow a risk of freight forwarder to entry the market is evaluated for all considered in the experiment values of freight forwarder tariffs, which are defined in a loop by *Tariff* variable (in the range from *minT* to *maxT* with the step *stT*).

Number of request servicing situations, for which freight forwarder profit is less or equal to zero, is fixed in a variable *n*. In a loop with the counter *i* an evaluation of forwarding enterprise profit and increment of variable *n* are implemented in case, if condition $P_{FF} \le 0$, where P_{FF} – freight forwarder profit, is satisfied.

In this way, for each couple of request interval mathematical expectation and freight forwarder tariff, the algorithm defines a probability value of non-obtaining by a forwarding enterprise of positive profit. Mentioned probability value here determines a measure of freight forwarder risk to entry the transportation market, it's defined in the algorithm as a ratio of value *n* and a number *N* of requests in a flow.

Calculation of a numeric value of freight forwarder profit is implemented with the help of *ForwarderProfit* function of *LogisticChain* class [8]. The function has two parameters – a boolean variable *tariffType* and the tariff value *Tariff*.

In case if *tariffType* is true, calculation of freight forwarder profit P_{FF}^{true} is conducted on the base of forwarder profitability rate according to the formula

$$P_{FF}^{true} = \left[s_{1h}^{FF} \cdot N_d^{FF} \cdot \left(I_r - \tilde{t}_{ser}\right) + s_{1h}^{FF} \cdot \tilde{t}_{ser}\right] \cdot \left(1 + R_{FF}\right) - E_{FF}^{\Sigma}, \quad (2)$$

where s_{1h}^{FF} – self costs of 1 hour of forwarding company dispatcher's work, \$/hr; N_d^{FF} – a number of freight forwarding company dispatchers; I_r – an interval of the request appearance, hrs; $\tilde{t}_{ser}$ – the request service duration, hrs; R_{FF} – profitability of freight forwarder services; E_{FF}^{Σ} – freight forwarder costs for the request service, \$.

Value of forwarding enterprise costs E_{FF}^{Σ} is defined with the help of *ForwarderExpenses* function of *LogisticChain* class [8].

For false value of *tariffType* parameter, calculation of forwarding enterprise profit P_{FF}^{false} is carried out on the basis of fixed tariff T_{FF} with the use of following dependence:

$$P_{FF}^{false} = T_{FF} - \left[s_{1h}^{FF} \cdot N_d^{FF} \cdot (I_r - \tilde{t}_{ser}) + s_{1h}^{FF} \cdot \tilde{t}_{ser}\right] - VAT - PT, \quad (3)$$

where *VAT* – value added tax, \$; *PT* – profit tax, \$.

Value added tax amount is evaluated on the basis of an appropriate value added tax rate δ_{VAT}:

$$VAT = \delta_{VAT} \cdot \frac{T_{FF} - s_{1h(paid)}^{FF} \cdot I_r}{100 + \delta_{VAT}}, \quad (4)$$

where $s_{1h(paid)}^{FF}$ – self costs of 1 hour of forwarding company dispatcher's work, which include the acquisition of goods and services of third-party companies, \$/hr.

Profit tax amount is calculated on the basis of net profit value *NP* and income tax rate δ_{PT}:

$$PT = \begin{cases} 0, \text{ if } NP \le 0, \\ 0{,}01 \cdot \delta_{PT} \cdot NP, \text{ if } NP > 0. \end{cases} \quad (5)$$

Net profit is calculated by the formula:

$$NP = T_{FF} - s_{1h}^{FF} \cdot N_d^{FF} \cdot (I_r - \tilde{t}_{ser}) - \\ - s_{1h}^{FF} \cdot \tilde{t}_{ser} - VAT + \frac{\delta_{VAT} \cdot s_{1h(paid)}^{FF} \cdot I_r}{100 + \delta_{VAT}}. \quad (6)$$

Described algorithm has been implemented in the development environment MS Visual Studio 10 with the use of C# ver. 4.0 language.

5. Results of simulation experiment on evaluation of freight forwarder risk to entry the transportation market

Evaluation of values of a probability of event $I_{FF} \le E_{FF}$ has been carried out for the values of an average requests interval in the range from *minI*=1 hr to *maxI*=10 hrs with the step *stI*=1 hr for the exponential distribution of the interval's stochastic value (accordingly to results obtained in [10]), and for forwarding enterprise tariff values in the range from *minT*=5 to *maxT*=23 \$/request with the step *stT*= =2 \$/request (the range of values of freight forwarders services costs for freight owners has been accepted in accordance with current tariffs on the transportation market for cargo deliveries in Ukraine)

Results of the simulation experiment, which has been implemented for determination of the dependence between freight forwarder risk and both tariff and requests interval values, are shown at Fig. 2. These results were obtained for the modeling period or 10^5 hrs.

Dependences of freight forwarder risk to entry the transportation market from tariff on the enterprise's services for different levels of requests interval are presented at Fig. 3.

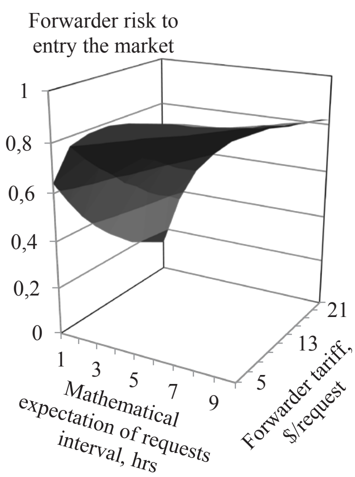

Fig. 2. Results of the simulations provided in order to determine the dependence of freight forwarder risk from tariff on company services and requests interval

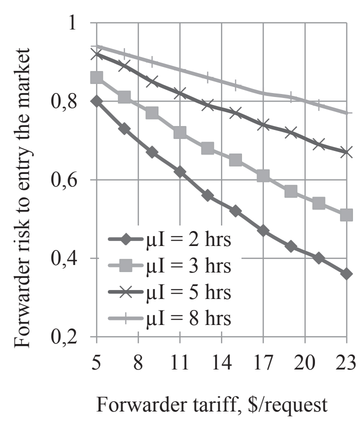

Fig. 3. Dependence of freight forwarder risk to entry the transportation market from tariff on the enterprise services

The primary analysis of the experiment results shows that forwarder risk to entry the market increases with decreasing of tariff on services of forwarding company and with increasing of mathematical expectation of requests interval. Also a non-linear character of requests interval and tariff influence on forwarder risk measure should be pointed out.

6. Results of regression analysis for the conducted simulation experiment

In order to determine the functional dependence $r = f(\mu_I, T_{FF})$, where μ_I – mathematical expectation of requests interval, the regression analysis was carried out with the use of MS Excel special tools. Regression analysis results allow to state that most adequately dependence of freight forwarder risk from requests interval and tariff rate could be described by a model of a following type:

$$r = 1 - \frac{0,0792 \cdot T_{FF}^{0,8588}}{\mu_I^{0,8016}}. \quad (7)$$

Regression model (7) was chosen from a set of 10 alternative hypotheses about form of dependence $r = f(\mu_I, T_{FF})$. Determination coefficient for model (7) had the highest value of 0,9888. In details the procedure of implemented regression analysis is described in [8].

Obtained regression model allows to estimate numerically a measure of freight forwarder risk for values of interval mathematical expectation from the range from 1 to 10 hrs and for the tariff values from the range from 5 $ to 23 $ per request. For the values of those parameters outside the mentioned ranges, the simulations of the process of requests servicing is needed.

7. Conclusions

Evaluation of freight forwarders risk to entry transportation market (or its segment) could be implemented on the basis of simulation freight forwarding process.

Provided results of research allow to make a conclusion, that forwarding company risk to entry the market monotonically increases with increasing of average requests interval in the serviced flow and monotonically decreases with increasing of the tariff on services of a freight forwarder.

Thus, to minimize the risk of freight forwarder to entry the market, there should be set ceiling level of the tariff value for the services of the company.

References

1. Vitlinskyi, V. V. Riskology in economy and business [Text] / V. V. Vitlinskyi, H. I. Velykoivanenko. – Kyiv: KNEU, 2004. – 480 p. [in Ukrainian]
2. Chancelier, J.-P. Risk aversion, road choice, and the one-armed bandit problem [Text] / J.-P. Chancelier, M. de Lara, A. de Palma // Transportation Science. – 2007. – Vol. 41, Issue 1. – P. 1–14. doi: 10.1287/trsc.1060.0179
3. Palma de, A. Risk Aversion, the Value of Information, and Traffic Equilibrium [Text] / A. de Palma, R. Lindsey, N. Picard // Transportation Science. – 2011. – Vol. 46, Issue 1. – P. 1–26. doi: 10.1287/trsc.1110.0357
4. Vidyarthi, N. Integrated Production-Inventory-Distribution System Design with Risk Pooling: Model Formulation and Heuristic Solution [Text] / N. Vidyarthi, E. Çelebi, S. Elhedhli, E. Jewkes // Transportation Science. – 2007. – Vol. 41, Issue 3. – P. 392–408. doi: 10.1287/trsc.1110.0357
5. Bergami, R. Managing Risks in International Freight Forwarding: An Australian Perspective [Text] / R. Bergami // The Vindobona Journal of International Commercial Law and Arbitration. – 2011. – Vol. 15, Issue 2. – P. 319–340.
6. Bergami, R. Managing Incoterms 2010 risks: tension with trade and banking practices [Text] / R. Bergami // International Journal of Economics and Business Research. – 2013. – Vol. 6, Issue 3. – P. 324–338. doi: 10.1504/ijebr.2013.056126
7. Naumov, V. S. Assessment of expediency of freight forwarder functioning at the transport market [Text] / V. S. Naumov // Bulletin of Transport and Industrial Economics. – 2009. – Vol. 26. – P. 114–117. [in Russian]
8. Naumov, V. S. Freight forwarding in logistics systems: Monograph [Text] / V. S. Naumov. – Kharkiv: KhNADU, 2012. – 220 p. [in Russian]
9. Dubrov, A. M. Simulations of risk situations in economy and business [Text] / A. M. Dubrov, B. A. Lagosha, E. Iu. Hrustaliov, T. P. Baranovskaja. – Moscow: Finances and Statistics, 2003. – 224 p. [in Russian]
10. Naumov, V. An approach to modelling of demand on freight forwarding services [Text] / V. Naumov // Trip Modelling and Demand Forecasting. – 2014. – Vol. 1, Issue 103. – P. 267–277.