

Influence of logistics development efficiency on the volume of foreign trade turnover of the world countries

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Abstract—The article summarizes the results of investigation the problem of assessing the impact of the level of logistics development on the goods turnover of the world countries. The paper shows the positive impact of the logistics development on the size of total exports and imports of goods and services, as well as theoretically and empirically justified factors which weaken and reinforce this effect. The exogenous factors are the level of economic development and the regional location of countries. When considering the created effect the most significant endogenous factors are the reduction of costs for customs processing and the possibility of organizing transportation between countries at relatively low prices.

Keywords—*international trade factors, foreign trade turnover, logistics development indices.*

I. INTRODUCTION

Currently, logistics is a significant factor in the development of international trade, but the development of various functional areas of logistics has a non-uniform impact on the volume of foreign trade.

The analysis performed by B. Shepherd [1, 2] on the basis of information on 45 countries showed that the share of gross domestic product (GDP) created in the logistics sector is on average about 5 percent. Obviously, taking into account the growth rate of world trade, the contribution of the logistics sector to national production in many countries will increase.

The purpose of this study is to identify the logistics sector which has the strongest impact on the volume of foreign trade of the world countries and a quantitative assessment of the impact size, taking into account differences in the level of economic development of countries and their location based on econometric analysis.

The object of research in this work is international trade, and the subject of research is the impact of the logistics development on the volume of export-import operations.

The authors have solved the following tasks: first, the main factors which have a significant impact on the size of the foreign trade turnover of the world countries are

identified; secondly, a hypothesis was formulated about the presence of specificity in the influence of the level of per capita income on the degree of development of logistics areas for various countries; thirdly, quantitative indicators were evaluated and selected which adequately reflected the corresponding qualitative changes; fourthly, an econometric modeling of the influence of these indicators on the volume of foreign trade turnover was carried out and the obtained results were interpreted.

II. METHODS

The conceptual basis of this study is the currently developed international trade theories, which somehow explain the factors which influence the size of foreign trade, and also help to determine the role of logistics development in increasing the volume of export-import operations. Using the provisions of the international trade theories make it possible to establish control variables, allowing one to distinguish the net effect of the development of various functional areas of logistics on foreign trade.

A. Basic theories of international trade

The first classical theory of foreign trade is A. Smith's theory of absolute advantages [3]. According to Smith, the country will export those goods for the production of which it spends less resources, compared to other countries. In accordance with the theory of comparative advantage of Ricardo [4], countries can be engaged in mutually beneficial trade with each other and can be specialized in creation of goods, the cost of which within the country is lower compared to another country. In the twentieth century, the theory of the classics was developed by multi-product models (studies by Dornbusch, Fisher and Samuelson [5]) and multi-country models (for example, in Eaton and Cortam [6]).

Among the factor theories, a special place is occupied by the theory of E.F. Heckscher and B.G. Olin, proving that the benefits also arise from the varying intensity of resource use. In the twentieth century, the level of trade between countries with similar characteristics increased, which somewhat did not correspond to the factor theories of international trade. A kind of generalization of the factor theories of world trade

was the theory of the international competitiveness of nations, developed by M. Porter [7].

The Krugman model [8] has two main elements: the production sector in each country is characterized by monopoly firms with the scale effect; utility increases as more product options appear for consumption. Modern studies in the theory of trade focus on microeconomic bases in the behavior of agents who decide to participate in international trade [9], as well as on the relationship between economic growth, trade and evolution of countries [10-15].

International logistics includes a range of services and processes related to the safe and reliable transportation of goods from one country to another: implementation of customs and administrative procedures; effective organization and management of international transport; timely tracking of cargo; providing high quality transport and information technology infrastructure. Such procedures can reduce transaction costs in international trade [16].

According to a study [17] conducted by Rutner et al., the volume of trade between the two countries is significantly affected by the availability and quality of logistics services, both in exporting countries and in importing countries. A study by Janie [18] showed the significance of the influence of the logistics development indices on both export and import.

Thus, the economic mechanism of the influence of the logistics development on the increase in export volumes is implemented by reducing the costs associated with the organization of international trade, including the following: reducing delivery times, which reduces storage costs and allows faster release of working capital [19]; optimization of not only material, but also informational and financial flows [20]; increasing the reliability of supply, which reduces the risk of loss of goods and associated costs; reducing transportation costs per se; improvement of the service, which stimulates new economic agents to interact with foreign partners.

B. Main model

The influence of various factors on the parameters of international trade in the literature has been studied in sufficient details. However, the impact of transactional logistic costs and instruments for reducing them on the global goods market should be further investigated.

The strongest impact from the logistics development should be expected for countries in which average per capita income is below the world average, since the countries of this group have a weaker production infrastructure at the start in order to be able to significantly increase the volume of foreign trade. Countries with an average per capita income level which is above average or high currently have a

relatively well-developed logistics infrastructure (see fig. 1), so additional investments in this area will have less effect. In addition, with the increase in the average per capita income level in the country, the value of exports and imports should increase.

Various logistic processes have various intensity of impact on the volumes of international trade. The strongest positive effect can be expected when affecting the parameters of “The term of customs clearance”, “Cost of organizing transportation” and “Reliability of deliveries”.

It can also be expected that the return from development of the logistics infrastructure will be different for different geographic areas.

Taking into account the possible impact of the degree of logistics development and other factors on the volume of trade, it is proposed to use a logarithmically linear model of the following type in order to test the hypotheses under consideration:

$$Y_{i,t} = \alpha X_{i,t} + \beta_1 LPI_{i,t} + \beta_2 X'_{i,t} \times LPI_{i,t} + \varepsilon_{i,t} \quad (1)$$

where $Y_{i,t}$ characterizes volume of external trade turnover; $X_{i,t}$ is matrix of control variables, the influence of which changes the efficiency of logistics development; $X'_{i,t}$ is the results from other factors, and $\varepsilon_{i,t}$ is one of the indices of logistics development.

As a resulting variable the logarithms of turnover is used. The control variables are the logarithms of GDP (ln_GDP) and country area (ln_AREA), the change in the purchasing power of the national currency against the US dollar (EXCH_gap), WTO and EU membership, as well as dummy variables which characterize belonging to a geographic region (REGION) and a group of countries by level of per capita income (INCOME).

As a rule, an increase in GDP is accompanied by an increase in the volume of both exports and imports. The vast territory is a source of significant resource opportunities, and also allows one to have a common border with a large number of partners.

As a rule, an increase in the purchasing power of the national currency against the US dollar leads to a rise in the cost of national exports for trading partners and, as a result, a decrease in export volumes with an increase in import volumes, therefore, both direct and feedback are possible.

International integration, manifested in participation in various trade unions, reduces trade barriers and stimulates international trade.

The main sources of information on the level of development of international logistics in this study are logistics development indices, which are calculated and

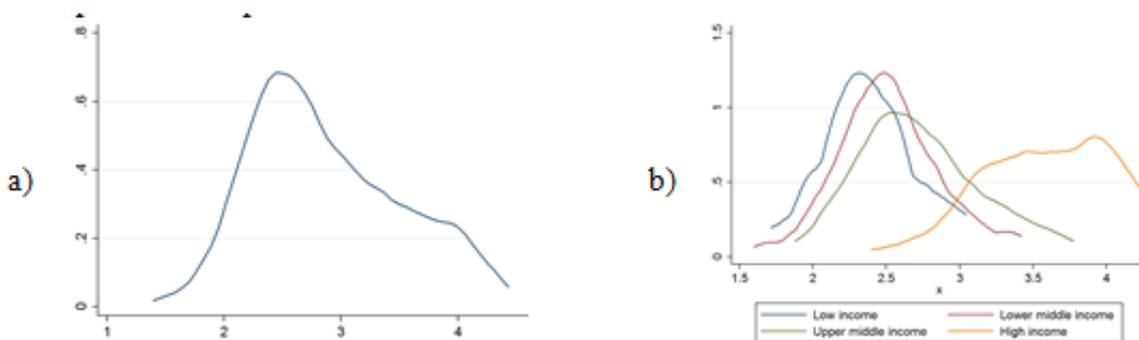


Fig. 1. Distribution of total logistics development index (min=1, max=5) for all countries of the world (a) and for groups of countries with different levels of per capita income (b), 2016. Based on data from the World Bank [21]

published by the World Bank. Criteria reflecting the effectiveness of the logistics system are evaluated on a five-point scale (1 is the lowest level and 5 is the highest). They cover all the most important aspects of the functioning of the logistics chain, competent coordination of which is necessary during implementation of export-import shipments.

The result is the overall logistics efficiency index (OVRL), calculated as the weighted average of the six partial logistics efficiency indices, which include: the frequency at which the goods reach the consignee at the planned or expected time (TIME); the ability to track cargo (TRAC); competence and quality of logistics services (LOGS); ease of shipping at competitive prices (ITRN); quality of trade and transport infrastructure (INFR); the effectiveness of the customs processing (CUST). The cross-section on time series is used as the base model, taking into account the available data.

C. Initial data

The World Bank database [21] was selected as an information base providing comparable reliable information, which was supplemented with some data from a study on the impact of colonial relations on cross-country trade [22].

The overall distribution of the logistics development index is close to normal, but it has right-sided asymmetry, which is due to the noticeably better development of the logistics infrastructure in countries with a high level of per capita income (see fig. 1b).

Based on the matrix of paired correlations of indices, it can be concluded that there is a close relationship between the indicators of the development of individual areas of logistics, which means that it is reasonable to include each of them separately.

The distribution of logarithms of foreign trade turnover (fig. 2) is bimodal, since economically developed countries form the majority of world trade, therefore, the use of dummy variables for categories of countries by income is necessary when building models.

The distribution of GDP logarithms is also close to normal, with almost no bimodality observed, as in the case of foreign trade, which indicates a greater uniformity of

The area of countries is also advisable to include in the model after logarithmization, since it brings the distribution of areas to normal.

III. RESULTS

Construction of models for assessing the influence of logistics development on the foreign trade turnover was carried out independently for each index of logistics development (see table 1). It should be noted that all constructed models are characterized by a high level of the determination coefficient ($R_a^2 \approx 0.94$) and statistical significance as a whole. The Broish – Pagan test showed the absence of residues heteroscedasticity in the models under consideration.

The obtained estimates confirmed a close positive relationship between the development of individual areas of logistics and the increase in the volume of foreign trade turnover, but the effect for different areas was not the same. Among the special indices, the organization of transportation at competitive prices (ITRN), the efficiency of the customs processing (CUST) and the quality of the trade and transport infrastructure (INFR) have the greatest effect.

In all models there was a significant positive relationship between the foreign trade turnover and the volume of total production (\ln_GDP), as well as the level of the country development. In full accordance with theoretical propositions, the influence of membership in trade unions was positive, however simple models did not allow to confirm the revealed connection at a high level of statistical significance.

The interaction term ($LPI \# \ln_AREA$) showed essential significance and incurred the negative effect of increasing the territory size. This can be interpreted in the sense that an increase in territory leads to an increase in general opportunities for organizing international trade, but reduces the size of the positive effect of improved logistics. Thus, taking into account the adjustment for the size of the country, an increase in the overall logistics development index (OVRL) by 1 point corresponds to an increase in the volume of foreign trade turnover by an average of 137.9%, and for special indices by about 5-15.

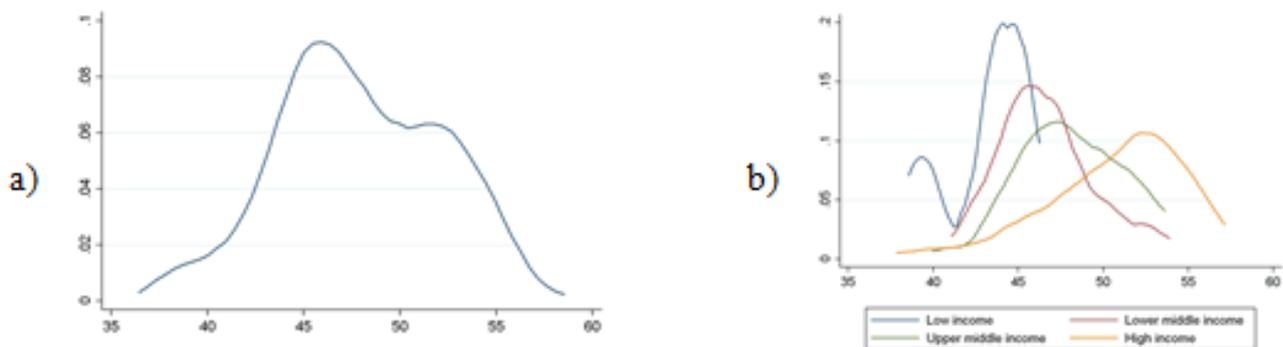


Fig. 2. The distribution of logarithms of foreign trade turnover for all countries of the world (a) and for groups of countries with various levels of average per capita income (b), 2016

distribution of total production across countries with different levels of per capita income.

TABLE I. MODEL OF INFLUENCE OF FOREIGN TRADE TURNOVER ON THE LOGISTICS DEVELOPMENT

Variable	Expected impact	OVRL	TIME	ITRN	INFR	CUST
ln_GDP	"+"	1.564***	1.708***	1.633***	1.597***	1.625***
EXCH_gap	"+/-"	-0.036	0.198	0.039	-0.123	0.039
WTO	"+"	0.315	0.361*	0.351*	0.287	0.372*
EU	"+"	0.352	0.312	0.354	0.493*	0.367
ln_AREA	"+"	0.852***	0.812***	0.777***	0.643***	0.627***
REGION						
E&CA	"+/-"	1.897*	0.240	2.650**	1.185	1.666*
LA&C	"+/-"	2.782*	0.435	3.365**	2.109*	1.812
ME&NA	"+/-"	0.765	0.364	1.806	0.235	1.247
NA	"+/-"	-1.849	-1.656	-0.389	-0.347	-0.490
SAsia	"+/-"	0.927	-2.565	1.376	0.938	1.848
SSA	"+/-"	1.296	-1.213	1.475	0.896	1.480
INCOME						
Lower middle income	"+"	-1.451	0.044	-0.736	-0.644	-0.599
Upper middle income	"+"	0.729	-0.053	0.288	1.148	1.138
High income	"+"	2.262	1.051	1.697	2.553*	3.009*
LPI	"+"	5.212***	3.748***	4.888***	4.425***	4.617***
LPI#ln_AREA	"-"	-0.303***	-0.283***	-0.292***	-0.248***	-0.254***
REGION #LPI						
E&CA	"+/-"	-0.638*	-0.160	-0.904**	-0.462*	-0.611*
LA&C	"-"	-1.149**	-0.380	-1.359**	-1.000**	-0.895*
ME&NA	"+/-"	-0.220	-0.154	-0.568	-0.089	-0.428
NA	"+/-"	0.697	0.639	0.289	0.314	0.347
SAsia	"-"	-0.531	0.599	-0.673	-0.633	-0.986
SSA	"-"	-0.623	0.186	-0.657	-0.555	-0.757
INCOME #LPI						
Lower middle income	"+/-"	0.784	0.133	0.502	0.505	0.511
Upper middle income	"+/-"	0.062	0.292	0.233	-0.150	-0.114
High income	"-"	-0.480	-0.023	-0.237	-0.686	-0.794
_cons		-6.574**	-6.341**	-7.052**	-3.957*	-5.105**

Note: * p<0.05; ** p<0.01; *** p<0.001

Belonging to the group of countries with a high level of per capita income leads to an increase in foreign trade turnover by an average of more than 9 times as compared with countries with a low level. For countries with incomes above average, the corresponding increase is about two times. At the same time, the additional effect of the development of logistics in richer countries turns out to be somewhat smaller than in poor countries, which is fully consistent with theoretical assumptions.

IV. DISCUSSION

In this paper, we examined the relationship between the volume of foreign trade turnover and the level of logistics development. With the help of econometric models, we were able to confirm both the existence of such a connection and the heterogeneity of the influence of improving logistics depending on the level of development and regional affiliation of countries. And most of the theoretical assumptions could be observed empirically.

Among the main areas of logistics, the development of which has the greatest influence on the increase in international trade, we can highlight the ease of organizing transportation at competitive prices and the efficiency of the customs clearance process. Consequently, it is these areas that should be given the most attention, for example, when setting priorities for state economic development programs.

This study, unfortunately, in fact, cannot solve the problem of causality, namely: a large volume of trade requires the development of logistics or the development of

logistics leads to an increase in foreign trade turnover. Most likely the process is reciprocal, and therefore investments in the development of logistics infrastructure will necessarily bring a positive effect on the development of international economic relations.

With regard to the Russian Federation, it can be noted that its current level of logistics development is lagging behind that for economically developed countries, which means that this factor creates additional reserves for increasing the volume of foreign trade turnover. In addition, although the vast territory of the country contributes to a noticeable reduction in the positive return on investment in logistics infrastructure, it creates additional opportunities that can become a significant competitive advantage for our country.

The development of this study involves many areas. First, it is worth considering the factors related to the common language and currency and the economic development of trading partners of countries participating in international trade, which can be implemented in models of gravity type, although it requires a significant increase in the amount of information processed. Secondly, in such models it is advisable to consider the lag effects, which can solve the problem of causality. At present, this is hampered by a relatively small history of fixing logistics development indices, however, over time such a study will become possible.

Consideration of models similar to those presented in this work for regions within one country can also provide

interesting results and formulate clear recommendations on financing the development of logistics at the government level.

ACKNOWLEDGEMENTS

The authors are grateful to the Yegor Gaidar Foundation for the opportunity to study modern econometric methods.

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