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ASSESSING THE IMPACT OF TRANSPORT AND LOGISTICS ON ECONOMIC GROWTH IN EMERGING ECONOMIES: A CASE STUDY FOR THE CONDITIONS OF THE REPUBLIC OF KAZAKHSTAN

Summary. This article examines the link between logistics indicators and economic growth in Kazakhstan in the period 1995-2019. Factors and the causal relationship between the indicators of transport development and economic growth, using the models of total production, demand and vector error correction, are studied. The analysis established specifics of the relationship between indicators of various types of transport and economic growth and their mutual influence, both in terms of directions and the nature of the relationship. A bi-directional cause-and-effect relationship between railway transport infrastructure and economic growth has been identified according to the Granger test. It was found that in a small economy, road and sea transport in the long term will lead to a higher rate of economic growth, and vice versa, economic growth encourages the development of pipeline transport and this in turn, in a one-way direction, stimulates the development of all other types of transport. It was revealed that economic growth in Kazakhstan leads to an increase in demand for transport and logistics services and their infrastructure to a lesser extent than in countries with large economies. To improve the effectiveness of the economy, a differentiated approach to transport policy is recommended depending on the highlighted long-term relationship between the studied parameters. Our research indicates that conditions for road and sea transport in Kazakhstan should be improved to stimulate economic growth. The results of the study can be used as recommendations for developing a long-term transport policy.

1. INTRODUCTION

World experience shows that the dynamic growth of the economy leads to a significant increase in the volume of goods traffic and, accordingly, cargo flows, both domestic and international, including transit. However, under the conditions of insufficient logistics, the productivity and efficiency of the country's transport complex are declining [4]. There are convincing data proving the existence of a dynamic relationship between the state of the national economy and the development of the country's transport industry.

Over the past 25 years - from 1995 to 2019 - Kazakhstan's GDP has grown 11.2 times and reached \$ 187.4 billion, and the volume of transport services increased 9.3 times to 21.6 billion in 2019. In 2019, 4237.9 million tons of cargo was transported by all modes of transport, which is 3.2 times more than that in 2000. The volume of investments in the transport sector has increased significantly – \$ 3.7 billion was invested in 2019.

In terms of cargo capacity, the economy of Kazakhstan is about 4 times less efficient. Thus, for each unit of GDP in dollar terms, there is at least 3.32 ton-kilometers of transport operation in 2019, and in the EU countries, the load capacity is less than 1 ton-kilometer/dollar of GDP.

Investment in the transport industry increased from \$ 350 million in 2000 to about \$ 3.5 billion in 2017. Over the past 10 years, annual investment in the transport industry has averaged \$ 3 billion. The investment is mainly directed toward rail and road transport, recently to the development of the Caspian Sea port in Western Kazakhstan, as well as to air transport.

However, there are many problems in the logistics industry of Kazakhstan. According to the Ministry of Industry and Development of Kazakhstan, the share of logistics costs in GDP is about 22%, which is 2.5 times more than that in developed countries of the world (8-12%). Also, the problems of logistics are a relatively low level of logistics efficiency, low government support, the lack of a single streamlined management system, and low professionalism.

Our research is based on the dynamic structural model proposed in the paper [6]. Using econometric models, we considered the causal relationship between logistics development and economic growth, both in the short and in the long term for the small economy of Kazakhstan, and conducted a comparative analysis of a similar model obtained in studies of China and India, which has a large economy.

The results of the study are expected to provide grounds for the development of logistics and recommendations for the development of transport infrastructure.

2. LITERARY REVIEW

The interaction and relationship between the transport industry and the economy are being studied quite actively. The effect of investing in transport infrastructure with subsequent economic growth, the interaction between different modes of transport, and the use of modern logistics technologies have been studied in many scientific papers. The reference book [4] examines in detail all the main factors underlying our understanding of transport planning in developed countries.

In the literature, there are different approaches to what is primary: the economy (structure and proportions in a given economic system) that affects transport or transport that stimulates the economy. In other words, does investment in transport cause economic growth or does economic growth encourage capital investment in transport infrastructure?

It is known that transport infrastructure significantly affects the productivity and cost structure of the economy. Lakshmanan, Andersen [15] from Boston University (USA) notes that the improvement in transport infrastructure and transport services leads to a decrease in the cost of cargo transportation and an increase in opportunities for access to various commodity markets, expanding the labor market.

The development of transport usually occurs in parallel with the growth of the economy, and the growth of the transport sector generates an increase in the share of employment and their income. Much of the work is devoted to examples of how transport development does not always lead to economic growth.

There are two opposite opinions in the transport economic community. Some represent the trend according to which the development of transport contributes to economic growth (with the development of the industry, the economy grows). Others argue that there is no direct link between the development of transport, or rather transport, and economic growth. However, the issues of side effects have not yet been sufficiently studied.

Studies of different countries using production functions have shown a positive relationship between infrastructure and economic growth, which is confirmed in works [2, 8, 20 and 21].

There is no universal theory describing the impact of transport and logistics on economic growth. For example, theoretical models [5, 15] show the influence of transport infrastructure on economic growth.

In recent decades, there have been studies aimed at building macroeconomic models [15], which make it possible to identify causal relationships between indicators of the development of the transport sector and economic growth.

In foreign studies, vector autoregression models (VAR models) are widely used [12; 24] and vector error correction [22; 26], as the most adequate toolkit for determining the presence of feedbacks

between the studied stationary variables. However, a significant limitation of the applicability of such models is the requirement for long time series to obtain reliable results.

Recently, the system dynamics method has been proven to be an effective tool for studying complex systems to identify cause-and-effect relationships [9]. In the work of Abbas, K.A et al. [1], an assessment of the strengths and weaknesses and the suitability of the system dynamics model in modeling the transport system was performed. Later, this model was used in the management of logistics and modeling supply chains [16], logistics, and economic growth [18]. However, the application of the system dynamics model requires significant time and other costs, and is sometimes more expensive than similar methods. With all the strengths of this model, it is not able to predict the development if any kind of randomness or qualitative changes in the environment occur in the future.

However, in the work of Rietveld [24] and Fleisher, B.M., Chen, J. [9], unambiguous answers about the influence of infrastructure on the development of the region were not found. Influences on economic growth and other factors are established: labor, capital, and investment.

Different types of logistic infrastructure can have different effects on economic growth.-In studies by Liu et al. [18] and Zhu et al. [27], a positive one-way causal relationship was found between logistics and economic growth. That is, on the one hand, logistics became the cause of economic growth; on the other, economic growth became the reason for the development of the logistics industry.

Gunasekera, K, et al. [12] established a short-term causal relationship between the economy and the length of highways. The short- and long-term causal relationships between economic growth and logistics (road, rail, number of deep-sea berths) have been studied [13]. These studies relate to developed countries with large economies.

In India [22], a bidirectional causal relationship was revealed between road transport and economic growth using the vector error correction model (VECM). There is also a two-way causal relationship between road transport and capital accumulation, between gross domestic capital accumulation and economic growth, and a one-way causal relationship between economic growth from rail transport and gross capital accumulation from rail transport. The authors suggest maintaining a suitable transport policy for the development of transport infrastructure and, consequently, for sustainable economic growth in India.

Mak B. et al. [20], using an autoregressive panel vector model to identify Granger causality, established a causal relationship between the following four variables: traffic intensity (air transport utilization rates per capita), scale of urbanization, CO₂ emissions, and economic growth in both the short and the long term. The main conclusion was as follows: the intensity of passenger traffic in the G-20 countries should be increased to stimulate economic growth.

The infrastructure of international transport corridors in Kazakhstan has undergone significant modernization. Nevertheless, in terms of transport connectivity, Kazakhstan still lags significantly behind most countries with highly developed logistics, which is partly due to the country's lack of access to the sea.

Other reasons for lagging are poor infrastructure quality, high transport costs, and significant time spent on crossing the border.

In this paper, we used the available data for the period from 1998 to 2019. Unlike many previous studies, we used the model of the cumulative production function and the four main components of logistics, that is, rail and road, sea, and pipeline transport.

3. METHODOLOGY

The main parameters used in the model were selected from different sources: [5, 13, 20, 26]. In addition, the indicator for the length of pipeline transport (PIPE) was included due to its significance. In Kazakhstan, GDP growth is strongly influenced by raw materials (oil, gas), which does not reflect the real picture of economic growth. For this reason, real GDP per capita (PGRGDP) is added (Table 1).

We determined the relationship between logistics and economic growth, as in the work of Roller and Waverman [23], but in contrast, the model includes the gross output of the transport industry.

We begin our study with the relationship between GDP and economic growth based on the Cai model [6], which considers the gross output of logistics in real terms as a function of economic growth, and add the two main factors of production - capital and labor [24].

Thus, the following model is obtained in terms of demand:

$$\ln RGDP_t = \alpha_1 + \beta_1(ROUTPUT_t) + \beta_2 \ln(INV_t) + \beta_3 \ln(LF_t) + \mu_t \quad (1)$$

where RGDP is the gross domestic product of Kazakhstan; ROUTPUT is the gross output of transport services (production); RINV is the investment (capital) in the transport industry; and LF is the number of employees in the transport industry.

In this model (1), we identify the impact of the volume of production in the transport industry, labor, and capital on economic growth, represented by GDP.

Roller and Waverman [23] used the penetration rate to study the relationship between logistics development and economic growth. Chinese researchers Cheng and Peng [7], and Liu et al. [18] used the freight turnover. Variable prices for logistics were added and a model was developed, in terms of demand. The cargo turnover model that determines the demand for cargo transportation is presented as follows:

$$\ln(PCLOG_t) = \alpha_1 + \beta_1 \ln(PCRGDP_t) + \beta_2 \ln(CPI_t) + \mu_t \quad (2)$$

Model (2) studies the impact on the volume of cargo turnover per capita (PCLOG) of such factors as 1) real GDP per capita (PCRGDP) and 2) consumer price index (CPI).

The production function model is widely used in the following works [13, 20, 26]. Infrastructure plays an important role in the production function [24]. According to Roller and Waverman's model [23], the production function links GDP to investment, labor, and productive capital. Based on the Roller and Waverman model [23], the production function links GDP to investment, labor, and production capital.

In this article, we use the discretization function, which includes the main transport components as explanatory variables to study the relationship between the development of logistics and economic growth.

To establish a cause-and-effect relationship between the variables of interest, we used the vector error correction model (VECM), estimated on the basis of this cointegration ratio.

We used the following vector error correction model (VECM) (a disaggregated release model):

$$\ln(RGDP_t) = \alpha_1 + \beta_1 \ln(INV_t) + \beta_2 \ln(LF_t) + \beta_3 \ln(RAIL_t) + \beta_4 \ln(ROAD_t) + \beta_5 \ln(MARINE_t) + \beta_6 \ln(PIPE_t) \quad (3)$$

In model (3), we studied the influence on RGDP of such factors as capital (RINV), employment (LF), the length of railways (RAIL) and highways (ROAD), the number of cargo berths in seaports (MARINE), and the length of the pipeline transport (PIPE).

To determine the direction of the relationship between GDP and factors (RINV, LF, RAIL, ROAD, MARINE, PIPE), the hypothesis of weak exogeneity (the significance of the correcting coefficient α in the error correction model) is tested, and the Granger causality test is applied to model the estimation results of VECM.

We checked the stationarity of the studied variables by the Dickey–Fuller and Phillips–Perron root units test. Next, we check the existence of a long-term relationship between transport and logistics and economic growth according to the Johansen and Juselius test [13].

In the VECM (general output or production model) model, we calculate the following dependent variables: $\Delta \ln RGDP_t$, $\Delta \ln ROUTPUT_t$, $\Delta \ln INV_t$, $\Delta \ln RS_t$, and ect_{t-1} depending on the following independent factors: RGDP, ROUTPUT, INV, and LF (see the first four lines of Table 4).

In the VECM (vector error correction model) of the demand model, the following dependent variables were calculated: $\Delta \ln PCLOG_t$, $\Delta \ln PCRGDP_t$, and $\Delta \ln IPS_t$ depending on the following independent factors: PCLOG, PCRGDP, and CPI (see the next three lines in the demand model of Table 4).

In VECM – the disaggregated output model (output disaggregation model) - the following dependent variables were calculated: $\Delta \ln RGDF_t$, $\Delta \ln INV_t$, $\Delta \ln LF_{t-1}$, $\Delta \ln RAIL_t$, $\Delta \ln ROAD_{t-1}$, $\Delta \ln MARINE_{t-1}$, $\Delta \ln PIPE_{t-1}$, and ect_{t-1} depending on the following independent factors: RGDP, INV, LF, RAIL, ROAD, MARINE, and PIPE.

Here, Δ is the first difference operator, and ect_{t-1} is the error correction period lagging by one period.

The main hypotheses are to test the null hypothesis (H_0): the growth of the studied indicator is not the reason for the growth of another indicator according to Granger [11].

As a calculation, we formulate the following hypotheses:

1a) H_0 : ROUTPUT growth is not the reason for the Granger GDP growth.

1b) H_1 : RGDP growth is not the reason for Granger ROUTPUT growth. By analogy, we determine causality for other indicators.

If both hypotheses are rejected, this indicates a two-way causality between ROUTPUT and RGDP. If the null hypothesis for (1a) is rejected, but the alternative hypothesis (1b) is not, there is a one-way causality from ROUTPUT to RGDP. Conversely, if the alternative hypothesis (1b) is rejected, but the null hypothesis (1a) is not, then there is unidirectional causality from RGDP to ROUTPUT. If none of hypotheses (1a) and (1b) is rejected, then there is no causal relationship between the studied variables.

4. INITIAL DATA AND ANALYSIS RESULTS

All obtained data are available on the website of the Bureau of Statistics of Kazakhstan (<http://stat.gov.kz>). The sampling period is from 1995 to 2019. Before use, the data were converted into a logarithmic form to achieve the stationarity of the series.

For logistics variables, we use the following Kazakhstan indicators: the length of existing railways (RAIL) (including national electrified railways), the length of roads (including expressways) - ROAD, the number of cargo berths in seaports (MARINE), the length of main pipelines (PIPE), the volume of cargo turnover per capita (PCLOG), the real output of the transport industry, the warehouse industry, and communications (ROUTPUT) (Table 1).

The results of the Granger model [28] also included the results of the following algorithm: descriptive statistics of indicators; testing series for single roots (Dickey–Fuller test); Johansen's cointegration test; definition of normalized long-term coefficients; and E. Granger's test for causality.

Calculations were carried out using the EViews program.

Table 2 shows the descriptive statistics for all variables. The asymmetry coefficient and the kurtosis are not equal or close to zero, which makes it impossible to approximate the normal distribution.

Table 1

Indicators used to study the relationship between GDP and transport in Kazakhstan

	Indicator	Designations	Unit of measurement
1	Real gross domestic product	RGDP	trillion tenge
2	Real GDP per capita	PGRGDP	million tenge
3	Real investment in the transport industry	RINV	trillion tenge
4	Labor in the transport industry	LF	million people
5	Length of existing railways	RAIL	thousand km
6	Length of roads	ROAD	thousand km
7	Number of cargo berths in seaports	MARINE	pieces
8	Length of pipeline transport	PIPE	thousand km
9	Cargo turnover of all types of transport per capita	PCLOG	mln.tkm / human
10	Consumer price index	CPI	%
11	Real gross output of transport, storage, and communications	ROUTPUT	trillion tenge

Table 2

Statistics of the studied variables

	Mean	Standard Deviation	Skewness	Kurtosis	Jarque–Bera test
RGDP	20.7918	20.9193	0.9226	-0.3042	5.2737
CPI	1.1148	0.1153	3.5423	14.1476	4.5664**
RINV	3.7408	3.0881	0.3847	-1.1937	2.0619
LF	0.4951	0.0778	0.7333	-0.9883	3.1915
RAIL	1.4936	0.0672	-0.1912	0.15051	3.2511
ROAD	9.2119	0.4525	-0.3131	-1.3623	3.6637
PCLOG	0.0318	0.0542	4.8229	23.7778	7.0140**
PIPE	18.6330	3.1599	0.4714	-1.4541	3.2151
PCRGDP	1.1937	1.1178	0.7478	-0.7478	3.5588
ROUTPUT	2.8508	2.2052	1.2085	0.3071	2.1510
MARINE	5.84	4.3462	0.5978	-0.7423	2.2347
**- 5% significance level					

Negative asymmetry values have LF, RAIL, and ROAD. The hypothesis of normality is rejected in CPI based on Jarque–Bera statistics at the 5% level. For CPI and PCLOG, we artificially reduced the distribution of primary test scores to the normal form. Thus, all parameters studied in table 2 can be used as parametric statistics methods for further analysis.

The results of ADF tests of series testing for a unit root $Y = (1)$ for each series showed that all variables are stationary, except for the MARINE indicator. The MARINE indicator is converted into a stationary form using the second difference of the series, that is, the ADF (2nd dif) is equal to 3.7120 at the level of 5%. Thus, in further studies, we obtained only stationary parameters.

We then move on to the Johansen–Juselius test to test the cointegration of the time series. It describes the estimated long-term coefficients of the variables. The normalized long-term ratios for each model are shown in Table 3.

In the total production model, the long-run ROUTPUT and INV ratios are positive.

This suggests that the economic growth of Kazakhstan in the long term will increase due to the development of logistics and investment, while the growth in the number of employed (LF) in the industry reduces economic growth.

In the INV, RAIL, MARINE, and PIPE vector correction models, they are statistically significant and positive for RGDP, while LF and PIPE MARINE show a negative effect.

After determining the number of lags and important variables, Granger causality tests were performed. The results of the Granger causality test are shown in Table 4.

These tests allow you to find out which variables have a significant impact on the Granger on each individual variable.

Table 3

Normalized long-run coefficients

Model	Dependent Variables	Constant	Independent variables					
			ROUTPUT	INV	LF			
Total Production Model	RGDP	7.4898***	10.326***	0.7604***	-0.0179			
Demand model	PCLOG	0.2374**	PCRGDP 0.1091***	CPI 0.0038**				
Vector Error Correction Model (VECM)	RGDP	-619.219**	INV 6.702**	LF -0.0126	RAIL 36.212***	ROAD -28.738	MARINE 205.547**	PIPE -0.3759
Note: *** - 1% - significance level, ** - 5% significance level, * - 10% significance level								

The first evaluated model considered the interrelationship of RGDP and ROUTPUT, INV, and LF. Then, RAIL, ROAD, MARINE, and PIPE were added to the model. Lag exclusion tests showed that

in most cases, the growth rate of rail, pipeline, marine, and road transport is significant. Therefore, these figures are retained in the models.

The first three panels (rows) show the F-statistic and the coefficients of the error term (ECT). One-way communication exists from the ROUTPUT side on the RGDP. In addition, INV and LF confer Granger causality to ROUTPUT. The negatively significant coefficients of the lagging ECT confirm the long-run equilibrium in the total output model.

Table 4 shows that there is no short-term causality between the variables in the demand model.

In the disaggregation model, the ECT coefficient (error correction coefficient) is significant and positive in the RAIL model at the 1% level. This statement means that in the long run, the following variables have Granger causality on RAIL (RGDP, INV, LF, ROAD, PIPE, and MARINE). ECT is significant for MARINE at 5%, which means that in the long run, the other six variables (RGDP, INV, LF, ROAD, PIPE, and RAIL) have Granger causality on MARINE. In the short term, a unidirectional causal relationship of RGDP, INV, ROAD, PIPE, and MARINE with RAIL has been identified.

The INV indicator has a one-sided causal effect on the LF indicator. However, there is no short-term causal relationship between the other two logical variables (ROAD, MARINE) and RGDP.

The INV indicator has a one-sided causal effect on the LF indicator. However, there is no short-term causal relationship between the other two logical variables (ROAD, MARINE) and RGDP.

Next, the significance of the dependent parameters according to Granger is checked. The test is called Granger's "strong or long-term verification of causality". A joint short-term and long-term causality test can be performed by testing joint hypotheses. We conduct a joint test only in models with long-term relationships.

The result of the joint short-term and long-term causality test is presented in the last two panels of table 4. Figure 1 shows the directions of causality between model variables. An interesting conclusion is that it will be possible to know which variable contributed to economic growth. Figure 1 shows the cause-and-effect relationship between the logistics variables for the total production model and the disaggregated output model.

Thus, the assessment of the long-term aspect of the relationship between economic growth and logistic parameters in the framework of the vector autoregression model (Table 4) using standard F-statistics with a high degree of statistical significance indicates the existence of a long-term relationship between the studied variables.

Table 4

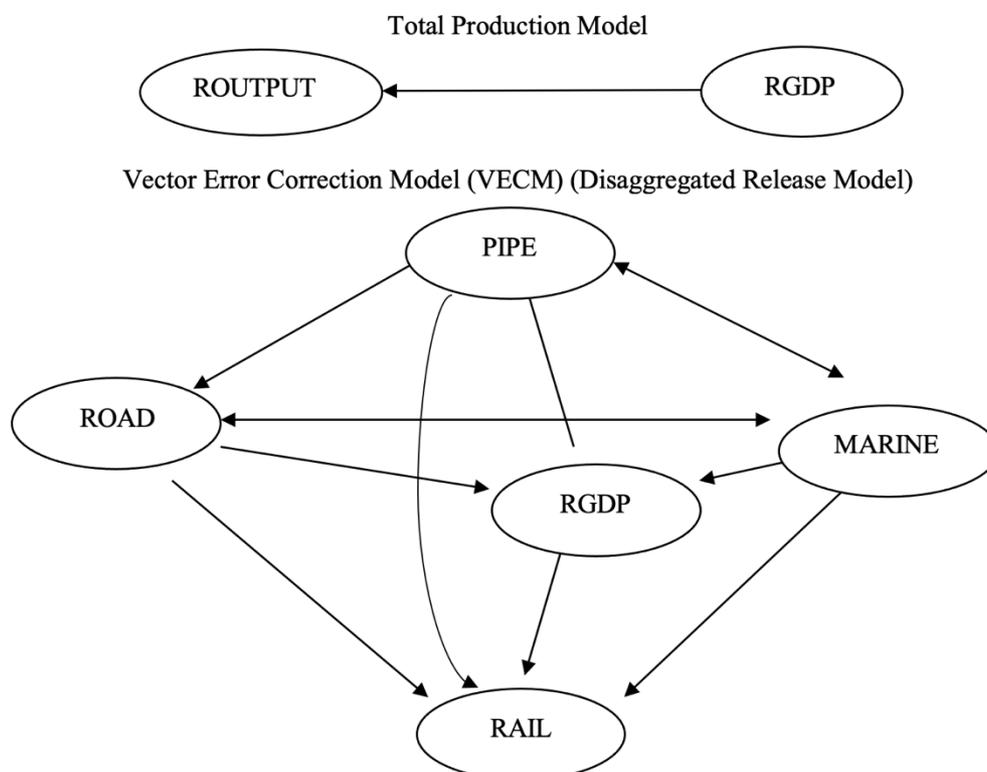
Results of the assessment of causality by the Granger test

Model	Dependent Variables	Short-term causality (F-statistics)						Coef. ECT	
		RGDP	ROUTPUT	INV	LF				
1.Total Production Model	RGDP	-	2.281	0.033	8.227			-0.161**	
	ROUTPUT	5.445*	-	12.235	6.52**			-0.352**	
	INV	2.223	1.442	-	6.712**			-0.428**	
	LF	0.131	1.341	1.684	-			-0.213**	
Short-term causality (F statistics)									
2.Demand model	PCLOG	-	1.846	0.228					
	PCRGDP	0.334	-	0.059					
	CPI	3.554*	0.077	-					
Short-term causality (F statistics)									
3.Vector Error Correction Model (VECM) (Disaggregated Release Model)	RGDP	-	0.033	3.636	4.337	0.188	0.577	2.342	0.062
	INV	2.223	-	6.712	2.898*	0.082	3.214*	3.017*	-0.073
	LF	0.130	1.084	-	4.141*	1.831	0.302	3.949**	-0.052
	RAIL	0.988	0.177	4.134	-	0.563	0.730	0.315	-0.160**

	ROAD	3.531	0.945	9.563	0.907	-	4.413***	3.387***	-0.004
	MARINE	3.762	0.164	5.971	1.883	12.862	-	4.985***	-0.021
	PIPE	0.699*	0.309	3.938	9.976	0.797	4.381	-	-0.105**
Joint short-term and long-term causality (F statistics)									
4.Total Production Model	RGDP	-	3.452	9.853** *	1.712				
	ROUTPUT	6.123**	-	6.782**	7.303**				
	INV	3.541	2.213	-	1.123				
	LF	0.853	0.823	8.203**	-				
Joint short-term and long-term causality (F statistics)									
5.Vector Error Correction Model (VECM) (Disaggregated Release Model)	RGDP	-	8.932***	4.783*	4.326*	4.523*	4.412	5.252*	
	INV	6.075**	-	6.121**	5.123*	5.123*	5.621*	6.323*	
	LF	1.231	7.703**	-	1.325	0.142	1.253	0.254	
	RAIL	4.541*	3.4122	4.123	-	2.412	2.742	3.025	
	ROAD	18.053***	17.821***	14.651* **	17.032* **	-	22.123***	16.146***	
	MARINE	6.102**	5.321*	4.832*	5.012**	5.854*	-	5.562	
	PIPE	8.266**	2.321	3.649*	10.347* *	2.941*	13.032***	-	

Note: The first three models present the results of the F statistics that were used to determine short-term causation. The fourth and fifth models show the results of F statistics that are used to estimate the combined short- and long-term causal relationship between the studied variables for:

- *** - 1% - significance level,
- ** - 5% significance level,
- * - 10% significance level.



Note: $A \rightarrow B$ shows that A has one-sided Granger causality to B. $A \leftrightarrow B$ shows the presence of two-sided causality between A and B. Source: built based on calculation results

Fig. 1. Joint short-term and long-term causality diagrams

Economic growth in Kazakhstan affects the development of road transport in a one-way direction, while in the long and short term, RGDP does not affect ROAD. ROAD's contribution to RGDP is weak due to the underdeveloped automotive infrastructure and its low density. However, we believe that for Kazakhstan, road transport will have a stronger impact in the long term than in the short term. GDP growth is not accompanied by large changes in ROAD indicators. This suggests that the vast territory, irrespective of the success of economic growth, requires improved transport services, whereas in China and India, this indicator has a two-way causal relationship [5, 9, 13].

5. DISCUSSION

Over the past 25 years, the development of transport and its infrastructure in Kazakhstan has been carried out continuously. The infrastructure of international transport corridors has undergone significant modernization.

The current level of transport financing, which is about 2.5 % of GDP, is much lower than that in countries with similar territorial characteristics. Actively developing countries invest up to 4-7 % of GDP in the transport sector [4].

In recent decades, transport and logistics have been considered as key drivers of economic growth in the EEU countries, including Kazakhstan. In this respect, the Central Asian countries can become the main logistics hub and transit point between China and Europe (the new Silk Road), China and Russia, and Europe and Central Asia [30].

Previously conducted studies on the long-term relationship between logistics development and economic growth using the total production model and the output model are established and confirmed [12, 22].

Based on the joint review of the short-term and long-term causal relationship test, we established a two-way relationship between RAIL and GDP, while in China and India, two indicators have a two-way relationship - RAIL and ROAD with economic growth. In Kazakhstan, there is a one-way communication from ROAD to RGDP, that is, a change in road transport has an impact on economic growth, and a direct link from GDP to ROAD is not found.

Economic growth is also causing a change in the PIPE long term.

There is also a one-way long-term causal relationship between economic growth and marine transport (MARINE).

We have found a one-sided long-term causal relationship between economic growth and marine transport. A long-term causal relationship from ROAD to RGDP has been found, i.e., that rail transport is the cause of the development of road and sea transport infrastructure and pipeline transport in a one-way direction along the Granger. It was also determined that pipeline transport is the cause of the development of water and road transport unilaterally.

In our model, only the railway became a cause with two-way communication. ROAD and MARINE have a one-way strong link to GDP. Pipeline transport (PIPE) does not have a direct link to GDP, but there is a feedback link to GDP in the long term. On the contrary, there is a long-term causal relationship, that is, a change in ROAD, MARINE, and PIPE causes a change in RAIL. This can be explained by the fact that RAIL initially developed separately as an independent important transport sector, without any relationship with other transport modes.

In the disaggregated output model, only one logistics variable (RAIL) caused economic growth in the two-way Granger direction. Freight turnover in the railway in 2019 occupies 46.5% of the total volume of cargo turnover and is transported over long distances. Therefore, initially, this type of transport plays an important role in export and transit transport.

The construction of roads, railways, and ports in the Caspian Sea and their constant modernization have caused an increase in transit and export cargo traffic and had an impact on the economic growth of Kazakhstan (an average of 3.0-4.5% annually over the past 10 years). Pipeline transport also had a

strong impact on economic growth. This was the result of increased investment in transport, especially in 2009-2014, which increased the length by 42.5% from 16,295 km to 23,196 km.

Improving the working conditions of land transport in the future can lead to economic growth by reducing the time and cost of transportation, gaining access to remote markets, etc.

Research shows that when improving and modernizing the development of the transport industry, such parameters as investment, labor, and development of RAIL and MARINE, ROAD have a significant impact and will have a multiplier effect on the economic development of other modes of transport and overall economic growth in the long term. ROAD, like PIPE, has less impact on economic growth.

The following features of the functioning of Kazakhstan's transport system and its impact on the economy are established.

First, there is a one-sided causality from the RGDP to maritime transport (MARINE). Among the possible explanations for a one-sided causal relationship between the RGDP and maritime transport include the following circumstance. The ports of Aktau and Kuryk are operating in Kazakhstan, with a total carrying capacity of about 26 million tons per year. The transshipment of goods is carried out efficiently, both in the direction of the ports of the Caspian states and toward Kazakhstan. On water transport, the main transit traffic goes through the port of Aktau.

Second: two-way communication and orientation from RGDP to RAIL, which is explained by the fact that the contribution of transport to economic growth is about 0,4-0,5%. This transport is mainly used for long-distance transportation.

Third, there is a two-way causal relationship between transports: ROAD and MARINE, MARINE and PIPE. The share of three types of transport (RAIL, PIPE, and MARINE) is 90% in cargo transportation and 51.6% in cargo turnover.

6. CONCLUSION

Let us summarize the analysis of the relationship between RGDP and logistic parameters.

1. All tests with a high degree of confidence indicate the presence of a long-term and short-term causal relationship between the studied parameters and economic growth, as well as between modes of transport.
2. According to the obtained estimates, the increase in the volume of real gross output in the transport industry has a statistically significant positive impact on the country's economic growth in the long term. An increase in the length of rail transport networks by 1% increases GDP in the long term by 0.36%. An increase in the length of highways by 1% reduces GDP in the long term by an amount of 0.28%. An increase in a pipeline transport by 1% leads to an increase in GDP by 0.0375%. The obtained estimates are consistent with the results of similar studies presented in foreign literature [1]. However, in major countries (China, India), it is slightly higher [13, 22]. For example, a 1% change in the length of railway transport leads to economic growth of 0.55-0.65%, road transport – 0.3-0.4%, and sea transport – 0.35-0.45%.
3. The results of the analysis showed that the length of transport infrastructure networks (RAIL, ROAD, PIPE) and the number of ports are strictly exogenous variables in relation to economic growth and cargo turnover. On the contrary, the volume of cargo turnover in the short term depends on the pace of economic growth and the pace of development of the transport industry.
4. The results of the analysis of the relationship between logistics parameters and economic growth showed that the pace of transport development and its impact on economic growth in Kazakhstan lag behind countries with large economies and developed logistics, such as China.

The study confirms that the logistics factors considered are significant, statistically significant factors of economic growth in Kazakhstan. The results of this analysis can be used to assess the contribution of transport infrastructure to economic growth and to plan the development of the transport industry and serve as an informational basis for working out ways to improve the price

and tariff policy in the domestic freight transport market. This direction may be the subject of further research.

5. Improving the functioning of road and water transport in the long term contributes to the development of the economy. It is revealed that land transport has a significant impact on economic development. This observation confirms the double effect of building transport infrastructure and digitalizing transport: improving the transport network stimulates economic growth by saving travel time, costs, etc., while economic growth leads to the development of transport infrastructure.

Since Kazakhstan's economy is still significantly correlated with commodity markets, which exhibit high volatility, the country needs to adopt a proactive approach and transform its industries to remain competitive.

In countries with high logistics costs and low logistics efficiency, such as Kazakhstan, improving transport infrastructure, including digitalization of transport, is important for future economic development.

Kazakhstan, initially, should develop the railway transport infrastructure, increase the level of automation and digitalization from 3.8% of GDP in 2018 to 5.5% of GDP, the level of developed countries, which will have a long-term effect and will stimulate the development of road, sea, and pipeline transport.

All these conditions should be taken into account when formulating a transport policy.

We believe that for a more accurate accounting and assessment of the mutual influence of modes of transport and logistics on the country's economy, additional research should be carried out in the future in the following areas. First, consider investment and labor factors separately for each mode of transport. Second, take into account logistics services and their impact on the economy by mode of transport. Third, taking into account the long-term forecast of the country's economic development, assess the transport policy using the system dynamics model.

In our opinion, such an approach will make it possible to achieve a greater economic effect from the transport industry on the economy, to better concentrate investments in those types of transport and logistics that the country desperately needs, to determine priorities for the development of modes of transport and logistics, and to reduce unreasonable costs for the development of unnecessary projects in the transport sector and the logistics industry.

These conclusions are important, first of all, for countries with a low starting level of transport infrastructure development, which includes Kazakhstan.

Based on the results obtained, it can be assumed that the following measures to improve transport infrastructure are important for Kazakhstan, and have the greatest impact on the economy: high-speed roads and high-speed railways that connect major cities in the most populated parts of the country, multimodal transport and logistics centers that streamline and accelerate the supply chain, as well as digitalization of logistics.

All this will allow the transport and logistics industry to give dynamics for reducing costs, improving business processes, and increasing their transparency and contribution to the economy.

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