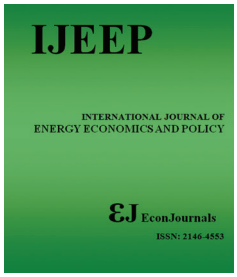

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The Effect of Freight and Passenger Transportation and Energy Production on Economic Growth in the Framework of Macro-Economic Indicators: The Case of Kazakhstan

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ABSTRACT

This study analyzes the impact of freight and passenger transport and energy production on the economic growth of Kazakhstan in the period 1996-2021 using the vector autoregressive models (VAR) model. The analysis also includes control variables such as energy production, economic growth, exchange rates, inflation, interest rates, foreign direct investment, and unemployment. The research uses data from the World Bank, the Central Bank of Kazakhstan, and the National Bureau of Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan. The findings showed that freight transportation's current and one-term lagged value affects economic growth. After determining the significance of the effect, we examined its causality. The findings concluded that none of the independent variables had a causal effect on economic growth, whereas the model with all three independent variables has. The study chose a long study interval and determined the data frequency as annual. The data period may be chosen as monthly or quarterly, and the effects of fluctuations during the year may be examined separately. As the timeline graph shows, the Covid-19 period created a significant statistical disruption for passenger transport. Future researchers may analyze this effect using the series from the pandemic period.

Keywords: Kazakhstan, Freight and Passenger Transportation, Energy Production, Economic Growth
JEL Classifications: C13, C20, C22

1. INTRODUCTION

It is of utmost importance to analyze macroeconomic indicators and sectoral performance to reach an economic growth level that will increase the welfare of a country and ensure its development. The freight and passenger transportation sector and energy production sectors impact economic growth. This study evaluates the impact of freight and passenger transport and energy production on Kazakhstan's economic growth.

Kazakhstan gained its independence in 1991 with the disintegration of the USSR and is the ninth-largest state in the world with its vast territory. After gaining independence, Kazakhstan reformed its economic structure to transition to a free market economy to ensure development and economic prosperity. This transition period has been successful thanks to Kazakhstan's rich natural resources. Kazakhstan has about 3% of the world's total oil reserves, about 1.1% of natural gas reserves, and about 3.3% of coal reserves, and its share in the world markets is growing even more with the newly discovered natural gas and oil deposits, especially on the Caspian coast (Mudarissov and Lee, 2014; Xiong et al., 2015; Bolganbayev et al., 2022; Myrzabekkyzy et al., 2022; Mashirova et al., 2023). Kazakhstan has rich fossil energy sources and renewable energy resources such as hydroelectric, solar, wind,

geothermal, and biofuels (Xiong et al., 2015; Ongarova, 2018; Taibek et al., 2023; Sabenova et al., 2023; Niyetalina et al., 2023). Its rich natural energy resources make Kazakhstan very attractive for foreign direct investors. Therefore Kazakhstan draws attention among developing countries with the economic growth rate it has achieved through reforms and investments in the last 30 years (Mukhtarov et al., 2020).

Its geographical location on the intersection of transportation routes between China, Russia, Eastern, and Western Europe also makes Kazakhstan an important player in the retail market. There are five international rail transit routes, six international transport corridors, and several major pipelines on the territory of Kazakhstan. The newly established international logistics centers of the Eurasian economic community in Kazakhstan will open up new opportunities for the future development of logistics services. Kazakhstan's transport infrastructure supports all modes of transportation, including rail, road, waterway, air, and pipeline. The transportation sector occupies an important place in the economy of Kazakhstan due to its broad geography and commodity-based economy. Therefore, Kazakhstan's logistics performance is among the factors affecting its economic growth (Bolganbayev and Parıltı, 2019).

The analysis framework of this study is to analyze the impact of freight and passenger transport and energy production on economic growth using macroeconomic indicators. The analysis includes macroeconomic indicators such as energy production, economic growth, exchange rates, inflation, interest rates, foreign direct investment, and unemployment. The effects of these indicators on sectoral performance were analyzed in detail.

This study aims to analyze the effects of freight and passenger transportation and energy production sectors on economic growth, to reveal the relations using macroeconomic indicators, and to shed light on future political decisions through the example of Kazakhstan.

2. LITERATURE REVIEW

Kazakhstan occupies an important position among the developing economies with its natural resource richness, unique geographical location, and economic growth and development that came with the structural reforms it made to adapt to global markets after gaining its independence in 1991. Hence there is a plenitude of academic studies in the literature on the economy of Kazakhstan. Here we will only touch on the main ones relevant to our subject.

Bolganbayev (2019), in his doctoral thesis study, discussed whether it is possible to establish a logistics center that will meet the expectations of both the country and companies from the developing logistics sector, and if possible, what the characteristics of the logistics center should be. He also analyzed the effects of developments in the logistics sector on GDP.

Bolganbayev and Parıltı (2019) analyzed the relationship between developments in the transportation sector and GDP in Kazakhstan, and this analysis is derived from the doctoral thesis Bolganbayev defended in 2019.

Raihan and Tuspekov (2022) analyzed the role of economic growth, renewable energy, and technological innovations in ensuring environmental sustainability in Kazakhstan. This study analyzed the time series data from 1996 to 2018 using the DOLS method. The research findings showed that the economic growth coefficient was positive and significant with CO_2 emissions, the predicted long-term coefficient of fossil fuel consumption was positive and significant, the renewable energy usage coefficient was negative and significant, and increasing technological innovations significantly reduced CO_2 emissions. Moreover, it has been determined that economic growth and fossil fuel consumption increase CO_2 emissions in Kazakhstan while increasing the usage of renewable energy and technological innovation helps to ensure environmental sustainability by reducing CO_2 emissions.

In their study, Bayraç and Çemrek (2019) analyzed the energy policies followed by Azerbaijan, Kazakhstan, and Turkmenistan after their independence, the relationship between oil production and economic growth, and the effects of the Dutch disease on these economies. In light of their findings, they suggested that all three countries should change the structure of their economies, which are all dependent on natural resources, should give importance to manufactured goods in foreign trade, should increase the number of countries they export, and should prioritize R&D to maintain more stable growth.

Ceyhan et al. (2016) analyzed the effect of the Kazakhstan economy's openness and inflation rates on its economic growth using the data between 1994 and 2013 with the autoregressive distributed lag method. They found that the openness ratio affects economic growth positively, but inflation has a negative effect on growth. They suggested that for Kazakhstan to increase its economic growth to the desired level in the long term and to maintain stable growth, it should reduce inflation and further its openness.

Özdil and Turdalieva (2015) examined the bases of economic growth in Kazakhstan using the input-output analysis approach. They aggregated the input-output results of the economy of Kazakhstan over eight main sectors (agriculture, mining, consumer goods, ınvestment goods, energy, construction, and services) and determined the sources of production increases in these sectors during the period.

3. DATA AND ECONOMETRIC METHOD

All commercial and industrial activities within a country have an impact on that country's economic growth. This study aims to investigate whether transportation activities affect economic growth. As the two primary aspects of the transportation sector are freight and passenger transportation, the most crucial component is energy usage. Therefore, it is a methodological must to include the energy variable, along with the transportation variable, in such a model. Moreover, a crucial factor to be considered in the analysis of national economies is the macroeconomic indicators,

which are an integral and natural part of a country's economy. Although it differs according to the economic structure of each country, these indicators include variables such as interest rate, foreign direct investments, unemployment, and exchange rate. In this study, we used macroeconomic indicators as a control variable. The data belonging to the 1996-2021 period were retrieved from the World Bank, the Central Bank of Kazakhstan, and the National Bureau of Statistics of the Strategic Planning and Reforms Agency of the Republic of Kazakhstan. (https://data.worldbank.org/indicator/BX.KLT.DINV.WD.GD.ZS?locations=KZ, https://www.nationalbank.kz/en, https://old.stat.gov.kz/official/industry/18/statistic/7).

Global energy production still heavily (85%) depends on fossil fuels (www.wikipedia.org). The effect of proportional changes in energy production from fossil sources on economic growth is also included in the model. For this purpose, the energy production variable was taken as the share of the energy produced from fossil fuels in the total energy production. Since the total energy production consists of two components, namely eco-friendly energy production and fossil energy production, our model also analyzes the effect of the share of eco-friendly energy production in total energy production. Research variables and their definitions are given in Table 1.

Stationarity in time series can be defined as the mean and variance of the series remaining constant in terms of the time variable, and the covariance depends only on the time between two data points. In analysis methods based on time series, stationarity is a must. In multivariate series, it is also a prerequisite for the variables to be stationary at the same level. The stationarity of a time series is examined by unit root tests or the correlogram graph method. This study uses the Augmented Dickey-Fuller (ADF) test. The test statistic is as in (1):

$$\Delta Y_t = \beta_0 + \beta_1 t + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_t \quad (1)$$

In the ADF test, if the null hypothesis is rejected for the value, the series is deemed stationary at the level (Sevüktekin and Nargeleçekenler, 2007).

Variables used in the economic analysis have a complex relationship structure by nature. This complexity arises from the variables themselves (the correlations between the raw data from which they are obtained) and their variation over time. One of the methods for examining the relations between variables, such as the relationship, effect, or causality, is the approach known as simultaneous equation modeling. This model defines some constraints depending on the nature of the variables to overcome the problem of model determination (Tarı and Bozkurt, 2006; Uysal et al., 2008). The superior aspect of VAR compared to the models based on simultaneous equation systems lies in that they do not define constraints on the model. This strength makes the VAR the preferred model for the time series analysis (Keating, 1990). The VAR model for the bivariate case can be expressed as follows.

Table 1: Variable names and definitions

Variable	Definition
X1	Transportation of goods by all modes of transport
X2	Passengers carried by all modes of transport
X3	Fossil fuels (% electricity)
K1	Foreign direct investment, net inflows (% of GDP)
K2	Inflation, consumer prices (annual %)
K3	Unemployment, total (% of total labor force) (national estimate)
K4	Deposits of non-banking legal entities
K5	Exchange rate
Y	Kazakhstan GDP growth (annual %)

$$y_t = a_1 + \sum_{i=1}^{p} b_{1i} y_{t-i} + \sum_{i=1}^{p} b_{2i} x_{t-i} + \varepsilon_{1t} \quad (2)$$

$$x_t = c_1 + \sum_{i=1}^{p} d_{1i} y_{t-i} + \sum_{i=1}^{p} d_{2i} x_{t-i} + \varepsilon_{2t} \quad (3)$$

In this model, p represents the lag length, and ε represents the error term with constant variance and zero covariance with lag values. The zero covariance of the error terms seems to be a constraint at first glance. However, the autocorrelation problem can be eliminated by increasing the lag length.

There are several methods for deciding the lag length in the VAR model. We determined the lag length using the sequential modified (LR), Final estimation error (FPE), Akaike information criterion (AIC), Schwarz information criterion (SC), and Hannan-Quinn information criterion (HQ) test values.

The goodness of fit of VAR models is examined through three different criteria. The first looks for a serial correlation in the residuals, the second looks for a variable variance problem, and the third looks for the AR characteristic inverse roots within the unit circle. Our model examined all three criteria.

When the effect between the variables in the analysis model is found to be statistically significant, the next step is to investigate the causality of this relationship. The method used for this is known as causality analysis. Causality analysis is developed by Granger (1969) and has a wide application area in examining the relationship between variables. In this study, causality analysis was applied within the framework of the VAR model. The possible causal effect of the independent variables on the dependent variable was examined for both the univariate and the multivariate case.

4. FINDINGS

This section analyzes the impact of freight and passenger transport and energy generation on the economic growth in Kazakhstan using the VAR method. The first step of the analysis provides the descriptive statistics and graphs of the series. The second step examined the stationarity of the series and included the same stationary data of all series in the analysis. And the third step applied VAR analysis and the appropriate lag level. This step also examined the fitness of the model, the variable variance problem, and the serial correlation problem through the criteria of inverse roots of the characteristic polynomial. Thus, the findings were

interpreted after the goodness of the model was established. The last stage of the analysis examined the level of the relationship between the independent variables and the dependent variable using the causality analysis. Thus our analysis of the research problem was completed.

Explanatory statistical findings for the research variables are given in Table 2. According to the average statistics, freight transportation is 2553 million tons, passenger transportation is 13,127 million people, the energy produced from fossil resources is 88.6%, foreign direct investments are 7%, inflation is 9.7%, unemployment is 7.7%, the interest rate is 7%, the exchange rate is 198.5, and economic growth is 5.2%.

The time path graphs of the series (Graph 1) show that freight transport in Kazakhstan has an increasing trend every year, while passenger transport has been in a remarkable decline in the years coinciding with the Covid-19 period. The unemployment rate is also showing a decreasing trend.

The stationarity of the series was examined with the ADF unit root test, and the findings obtained are given in Table 3. All series except K1, K2, and K4 series are both fixed and stationary at the first difference for the trend model. In line with the findings obtained, the first differences of the series were taken, and VAR analysis was applied.

The lag length criteria findings preferred for the VAR model are given in Table 4. The lag value (1) obtained for the FPE, AIC, SC, and HQ criteria was taken as the optimum.

The estimation findings of the VAR(1) model in Table 5 show that the current value of freight transport on economic growth is positive, while the one-period lagged value is negative and significant. The effects of passenger transportation and energy production from fossil sources were not statistically significant. The adjusted R-square value for the model was calculated as 0.377. This result is interpreted as 37.7% of the variability in economic growth is explained by the independent and control variables in the model.

Table 2: Descriptive statistics of research series

Statistics	K1	K2	K3	K4	K5	X1	X2	X3	Y
Mean	7.001	9.712	7.673	7.003	198.500	2553	13127	88.600	5.203
Median	6.261	7.420	6.590	5.700	148.400	2156	10876	88.560	4.400
Maximum	13.010	39.180	13.460	23.700	434.800	4222	23835	91.650	13.500
Minimum	0.196	5.097	4.800	2.600	74.000	1065	5000	84.750	2.500
SD	3.861	6.889	3.113	4.809	114.100	1115	6349	2.013	4.142
Skewness	0.201	3.248	0.803	2.365	0.992	0.178	0.520	0.119	0.033
Kurtosis	1.829	14.090	2.177	8.312	2.408	1.459	1.710	2.007	2.175
Jarque-Bera	1.659	179.000	3.529	54.820	4.651	2.709	2.976	1.128	0.742
Probability	0.436	0.000	0.171	0.000	0.097	0.258	0.225	0.568	0.689
Observations	26	26	26	26	26	26	26	26	26

Table 3: Augmented Dickey-Fuller test findings for the stationarity of series

Variable code	Level				First difference			
	Constant		Constant, Linear Trend		Constant		Constant, Linear Trend	
	t-Statistics	P-value	t-Statistics	P-value	t-Statistics	P-value	t-Statistics	P-value
Y	−2.4787	0.1323	−2.7398	0.2305	−4.4994	0.0018	−4.7144	0.0053
X1	−0.0631	0.9434	−2.7798	0.2172	−3.2992	0.0263	−3.9930	0.0393
X2	−1.3095	0.6088	0.1784	0.9963	−3.6644	0.0118	−4.0018	0.0229
X3	−1.3736	0.5786	−1.1265	0.9039	−3.8612	0.0076	−3.7269	0.0408
K1	−3.0703	0.0420	−3.9455	0.0250	−3.0757	0.0458	−3.9480	0.0302
K2	−8.5501	0.0000	−7.7655	0.0000	−5.9681	0.0001	−5.6897	0.0006
K3	−1.7716	0.3850	−0.3707	0.9831	−3.5568	0.0010	−3.8748	0.0412
K4	−5.1641	0.0003	−5.4478	0.0009	−6.4800	0.0000	−6.1758	0.0002
K5	0.348706	0.9762	−1.1103	0.9070	−4.7562	0.0009	−4.9085	0.0033
Test critical values								
1% level	−3.72407		−4.37431		−3.75295		−4.41635	
5% level	−2.98623		−3.6032		−2.99806		−3.62203	
10% level	−2.6326		−3.23805		−2.63875		−3.24859	

Table 4: Optimal lag length findings for the vector autoregressive models model

Lag	LogL	LR: sequential modified LR test statistic (each test at 5% level)	FPE: Final Prediction Error	AIC: Akaike Information Criterion	SC: Schwarz Information Criterion	HQ: Hannan-Quinn Information Criterion
0	1959.442	NA*	1.98e-77	−165.865	−163.297	−165.219
1	1973.110	−11.8846	9.82e-79*	−168.4443*	−166.6670*	−167.9973*
2	1937.453	−11.4729	1.58e-75	−162.561	−159.204	−161.717

*Indicates lag order selected by the criterion

Graph 1: Time path plot for series

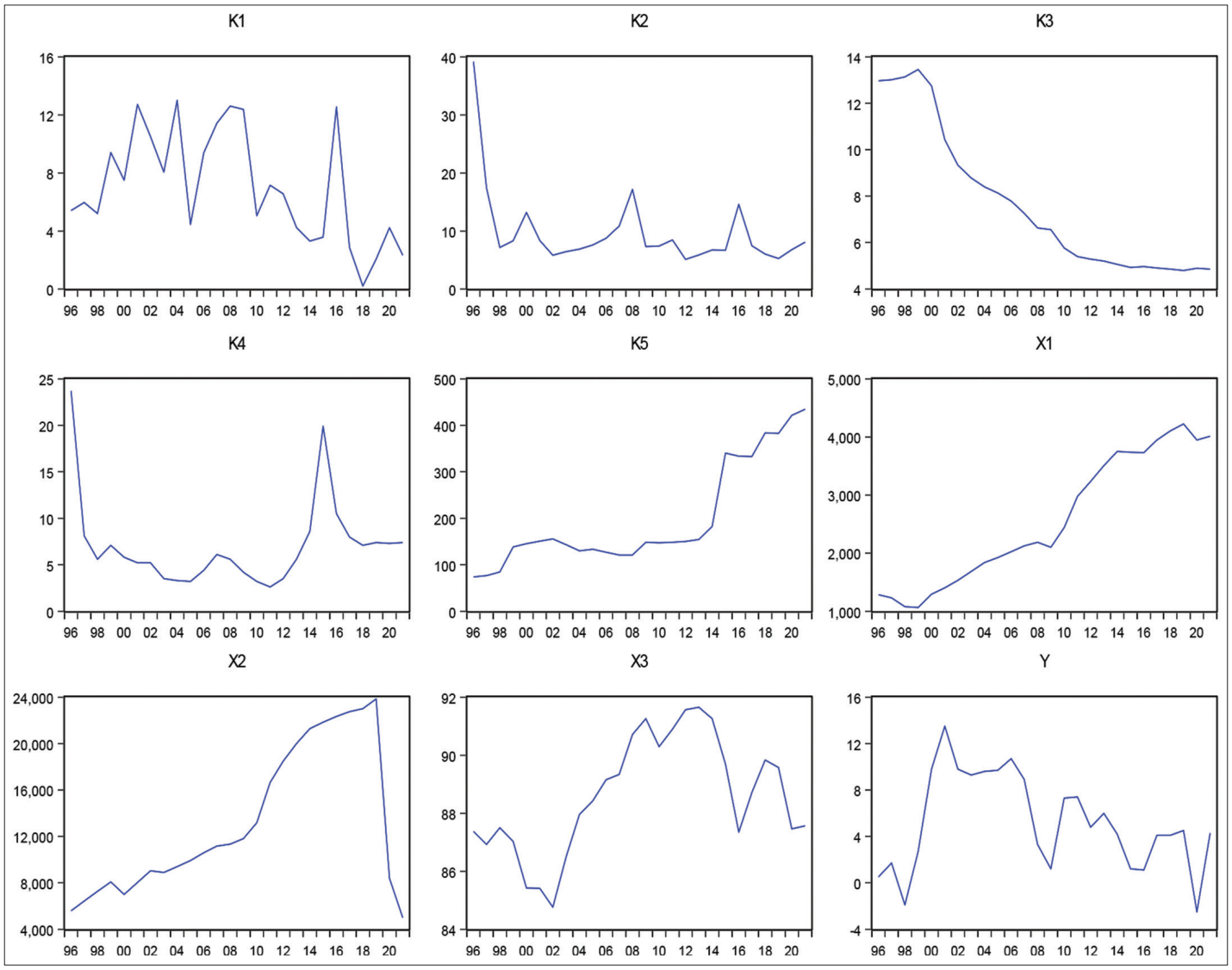

Table 5: Prediction findings of vector autoregressive models (1) model

Variable	Coefficient	Standard Error	t-Statistic (Prob.)
DY(-1)	−0.03934	0.27033	0.14553
DX1(-1)	−0.01453	0.00596	2.43715
DX2(-1)	−0.00023	0.00027	0.83010
DX3(-1)	0.438621	0.69428	0.63176
C	−1.09967	1.53793	0.71503
DK1	0.085841	0.18593	0.46168
DK2	−0.15608	0.19279	0.80959
DK3	−1.05976	1.54318	0.68673
DK4	−0.10463	0.33054	0.31654
DK5	0.018134	0.03441	0.52703
DX1	0.018728	0.00762	2.45931
DX2	−1.87E-05	0.00029	0.06458
DX3	−0.57474	0.77482	0.74178
R-square	0.702384		
Adjusted R-squared	0.377712		
F statistics	4.163367		
Log likelihood	−50.3694		
Akaike information criteria	5.280784		

Table 6: Serial correlation and varying variance findings of the research model

Residual serial correlation LM tests			
Lag	**LRE* stat**	**df**	**Prob,**
1	16.00730	16	0.4525
2	20.65856	16	0.1920
Residual heteroskedasticity tests			
Chi-square		**df**	**Prob,**
141.2556		140	0.4544

The graphical representation for the inverse roots criterion of the AR characteristic polynomial for the compatibility of the VAR(1) model is given in Graph 2. All the inverse roots of the model are within the unit circle. This indicates the compatibility of the model.

Table 6 presents the findings of two criteria for model compatibility. The existence of the serial correlation problem in the VAR(1) model was examined using the LM test, and no serial correlation

Graph 2: The plot of inverse roots of the AR characteristic polynomial of the vector autoregressive models

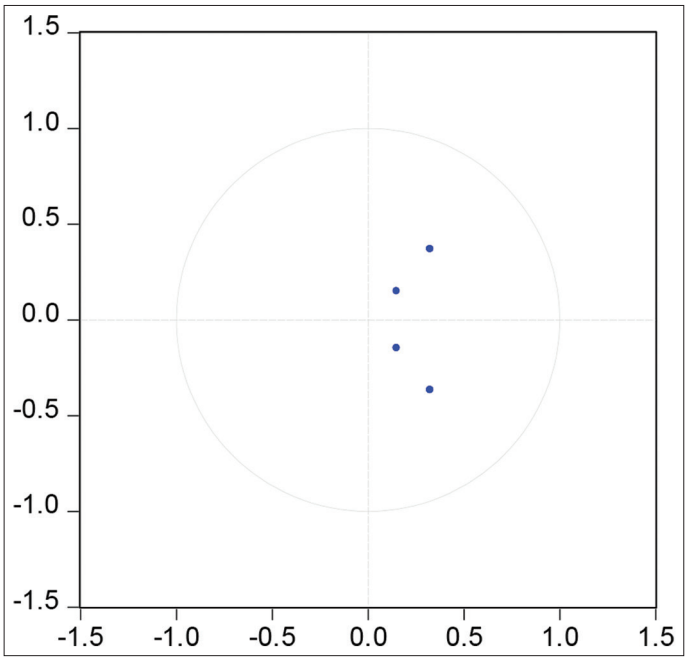

Table 7: Granger causality analysis findings of research series

Variable	Chi-square	df	Prob,
DX3	5.68E-06	1	0.9981
DX2	1.316530	1	0.2512
DX1	2.617937	1	0.1057
ALL	8.141595	3	0.0432

problem was found. The Residual Heteroskedasticity Test showed no changing variance problem. When the findings in Graph 2 and Table 6 are considered together, it is concluded that the research model is compatible and consistent.

Table 5 shows that the effect of one of the independent variables in the model (freight transportation) on economic growth is statistically significant. Thereupon, Granger causality analysis was performed to answer the question of the causality of the relationship between the independent variables and the dependent variable, and the findings obtained are given in Table 7. Accordingly, the dependent variable has no causal relationship with any three independent variables. However, all three of the independent variables together have a causal effect on economic growth.

5. CONCLUSION AND RECOMMENDATIONS

It is a reasonable expectation that all economic activity in a country will affect economic growth. For this reason, in this study, the effect of developments in the transportation sector, which is the most important sector in the economy of Kazakhstan, on economic growth has been examined. Moreover, energy generation, one of the most fundamental components of the transportation sector, was included in the model to obtain a more holistic analysis. The importance of such an approach has become evident in the causality analysis. The three-variable model revealed that freight and passenger transport and energy production, taken together, have a causal effect on economic growth. Our analysis has shown that the current value of freight transport has a positive effect on economic growth, while its one-period lagged value has a negative impact, and this finding should be interpreted considering Kazakhstan's economy. This result implies that the relationship between economic growth and transportation is a long-term relationship structure, and its analysis using ECM models (Error correction models) is an important research topic, especially for decision-makers.

This study both preferred a long period for the data and chose annual as the data period. In future studies, monthly or quarterly data periods may be used, and fluctuations within the year may be analyzed further. As seen in the time path graph, the Covid-19 period is a skewness period. It is again an open research topic to investigate this relation to series from the pandemic period.

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