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The Relationship Between Industrial Production and Economic Growth: The Case of Kyrgyzstan, Kazakhstan and Russia

(Sayfa 20-35)

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Abstract

This study examines the relationship between industrial production and economic growth in Kyrgyzstan, Kazakhstan and Russia. By analyzing data on the distribution of production and inputs in these countries, the research sheds light on the important role of the industrial sector in driving economic development. The findings reveal a positive and strong relationship between industrial production and economic growth and emphasize the importance of sustained investment and market reforms in promoting sectoral expansion. Through Granger causality tests, the study identifies causal links between economic growth and industrial production, underscoring the potential of targeted policies to boost industrial performance and promote overall economic progress. However, in Kyrgyzstan, growth is impressive for non-industrial sectors, while in Kazakhstan, the contribution of non-industrial sectors to growth is greater. In Russia, both variables interact with each other. These results provide valuable insights for policymakers and stakeholders to leverage industrial production as a catalyst for long-term economic prosperity in the region.

Keywords: Industrial Production, Economic Growth, Kyrgyzstan, Kazakhstan, Russia

JEL CODE: O14, L52, L88

Çalışma Alanı: Makro İktisat

1. Introduction

There is a close relationship between industrial production and economic growth. Industrial production is an important component of a country's activities and is often one of the factors affecting economic growth. Economic growth plays a fundamental role in the development of a country, as it is associated with various factors that determine the overall state of the economy. These factors include technological developments, the state of human resources in the country and advances in the industrial sector, as well as several other economic factors. These factors affect economic growth by determining the economic growth potential of a country and the dynamics that drive it (Yılmaz, 2005:63). A fundamental factor in the economic development of a country is the increase in industrial volume. In other words, progress in industrial production is considered as the pioneer of the economy. Especially if industrial production is oriented towards high value-added products, economic development can be realized in a long-term and sustainable manner. Russian industry is the locomotive of the national economy (Bukkvoll, Malmlöf and Makienko, 2017). Therefore, it is of great importance to sustain

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the growth and development of the manufacturing industry, which is one of the main sources of the growing country's economy (North, 1996). Russia adopted a state-led industrialization strategy under the conditions of the world depression that emerged in 1929. At that time, the state intervened in the economy and entered the market as an investor and producer and carried out the first industrialization movements with its own hands. However, even though investments in the industrial sector accounted for only 2% of GDP in this period and that state-led investments were limited in this period, industrial production was increased by activating idle industrial capacities in this process. In fact, the share of the industrial sector in the national product increased from 9.9% in 1929 to 13.8% in 1939. All these developments in the sector were interrupted by the Second World War, and rising input prices and labor shortages reduced industrial production by an average of 5.5% between 1940 and 1945 (Goldsmith, 1961).

In the industrialization process, there are two important models for developing countries from the mid-20th century to the present day. These are the import-substitution industrialization model and the export-oriented industrialization model (Dinçer. Yuksel and Adalı, 2018). Until the 1980s, import-substitution industrialization in Russia was based on the promotion of domestic industry to ensure that imported products were produced by domestic industry. Export-led industrialization (growth), on the other hand, is based on the removal of barriers to foreign trade and measures to increase exports to ensure economic growth through industrial exports (Romer, 1986). Before 1980, Russia adopted an import-substitution industrialization policy to protect and develop domestic production. It was aimed at producing in certain sectors, which resulted in loss of income. Since 1980, an export-oriented industrialization policy was adopted. It was aimed to increase competition in international markets by producing products with higher added value. For this reason, the industrial sector was given special importance. Support to the sector was increased (Aganbegyan, 2019). The growth rate of the sector, which was negative in 1979 and 1980, has been positive after this turning point, except for the crisis periods.

After this period, the industrial sector became the most important driver of economic growth. Historically, when the Russian economy is analyzed in recent periods, foreign trade policy towards industrial goods has taken two different forms. The first one is the import-substitution industrialization policy based on protectionism, which was pursued especially in the 1970s. The second is the export-oriented industrialization policy implemented in the Russian economy after the 1980s (Ivanter, 2019). The main objective of the export-oriented industrialization policy is to create an industrial sector integrated with the international economy. With the liberalization of foreign trade, the increase in the manufacturing industry sector has also increased exports.

The production flexibility of the agricultural sector is low as it requires a certain period and is easily affected by climatic conditions. Moreover, the demand for agricultural products is a derived demand and usually constitutes a small percentage of the demand for final goods. The inelasticity of supply and demand makes the national economy easily affected by instability in the international market (Runkle, 1991). For example, it fails in situations that require flexibility, such as taking advantage of favorable developments in international markets and avoiding the disadvantages of unfavorable developments. High

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dependence on the agricultural sector also plays an important role in terms of trade distortions.

Kaldor's law, which focuses on the relationship between economic growth and industrial production, is a theory put forward by Nicholas Kaldor. He argued that the industrial sector is the engine of economic growth, especially in developed countries. This theory argues that industrialization plays a key role for economic growth and is based on three basic laws: 1. the relationship between industrial production and GDP, 2. productivity growth, 3. the relationship between employment and productivity. With these laws, Kaldor argues that the industrial sector causes more productivity growth than other sectors and therefore industrial production should be encouraged for economic growth (Kaldor, 1966).

Kazakhstan's efforts to boost foreign direct investment are ongoing. To encourage foreign direct investment, the government enacted tax breaks in 2014. These comprised a ten-year freeze on other types of taxes, an eight-year exemption from real estate taxes, and a ten-year exemption from corporate taxes. The goal of these policies is to attract foreign capital to accelerate Kazakhstan's economic expansion. With the interruption of fuel and raw material supplies and the disappearance of Soviet markets, Kyrgyzstan's industries experienced precipitous drops in production during the post-Soviet era. Industry's contribution to GDP, excluding gold production, was just 14% in 2005, indicating that the sector has not fully recovered from this decline. The power sector, which has historically contributed significantly to the industry's GDP, has experienced stagnation in recent years, with investment and restructuring remaining low. Clothing and textiles are receiving more state assistance than the machinery industries, which constituted a significant portion of the Soviet economy (Aizhan and Diana, 2013). The mining industry in Kyrgyzstan contributes significantly to the country's economy by extracting its rich mineral resources. Gold mining is one of the largest industries in the country. The most significant aspect of the industrial sector is the extraction and processing of gold and other precious minerals. The glass industry has been expanding in recent years due to recent developments. Glass is produced for both consumer goods and the construction industry. The industry's competitiveness is enhanced by the quality and manufacturing potential of glass and ceramic products.

Before its decline in 2004, food processing accounted for 10 to 15 percent of industrial production. In terms of investment received and GDP contribution, the glass industry has outperformed the apparel and textile sectors in recent years. Large-scale infrastructure projects, including new gold mines and highways, contributed to steady growth in the construction industry in the early 2000s. However, a lack of investment has caused a slowdown in residential construction. For workers leaving industry, agriculture continues to be a stable option and a crucial component of Kyrgyzstan's economy. There was an upsurge in subsistence farming in the early 2000s. Agricultural production returned to near 1991 levels after experiencing severe reductions in the early 1990s. Most agricultural workers are employed in cattle grazing in the uplands and grain production in the lower valleys. Farmers also transitioned to growing tobacco, cotton, and grains. Dairy products, hay, animal feed, potatoes, vegetables, and sugar beets are other significant crops. The three main contributors to agricultural output are state farms (5%), private farms (40%), and private family land (55%). Further expansion of the sector depends on banking reform

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to increase investment and market reform to facilitate the distribution of agricultural inputs. The controversial topic of land reform in Kyrgyzstan has progressed very slowly since the initial laws were passed in 1998. The infrastructure for irrigation is in poor condition. Approximately one-third of the GDP and over one-third of jobs are generated by agriculture (Economy of Kyrgyzstan, 2019).

2. Studies in Literature

In empirical studies on the effect of industrial production index on economic growth, it is generally accepted in the literature that there is a positive and strong relationship between industrial production index and economic growth. However, a study conducted by Stoneman in 1979 on the UK economy failed to find any relationship between the two variables. Studies on this subject can be listed as follows.

Table 1. Literature Summary

Author	Period and Scope	Method	Findings
Kaldor (1966)	1953-1954 (Latin America)	Johansen cointegration and ECM	There are statistically significant relationships between industry and economic growth.
Drakopoulos and Theodossiou (1991)	1972-1991 (Greece)	Regression Analysis	It does not support the existence of a relationship between manufacturing industry and economic growth for Greece.
Yamak (2000)	1946-1995 (Turkey)	Co-integration and error correction model	Kaldor's hypothesis was tested, and supportive findings were obtained.
Mahonye and Mandishara (2015)	1990-2014 (Zimbabve)	EKK-GMM	They stated that there is a positive relationship between industrial production and economic growth and that they are important factors that directly affect
Moreno-Brid, Santamaría, & Rivas Valdivia (2005)	1980-2005 (Mexico)	Granger Causality Analysis	The analysis revealed a bidirectional causality between industrial production and economic growth.
Libanio Gilberto (2006)	1985-2001 (Latin America)	Panel data analysis	They proved that the causality relationship between the industrial production index and GDP per capita is positive and bidirectional.
Terzi and Oltulular (2004)	1987-2001 (Turkey)	Unit root, simple causality cointegration	He concluded that the causality relationship between industrial production and economic growth in Turkey is positive.
Arisoy (2013)	1963-2015 (14 EU countries)	Co-integration	Cointegration relationship was found between the variables. It also proved that there is a unidirectional causality relationship from economic growth to the industrial sector.

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Cetin (2009)	1981-2007 (Turkey)	Dynamic panel analysis	He found that the relationship between industrial production and economic growth in Turkey and 10 EU countries is positive and significant.
Kubar (2016)	1995-2010	Cointegration	It is concluded that the industrial sector value added has a positive impact on economic growth in underdeveloped and developing countries.
Kızılkaya (2016)	1999-2013 (Turkey)	ARDL test	They determined the existence of an integration relationship between the variables. They proved that there is a bidirectional causality relationship between manufacturing industry production growth and economic growth.
Usta (2016)	2004-2011 (Turkey)	Dynamic panel analysis	Author identified that industrial production and economic growth in Turkey are positively correlated in terms of causality.
Kara ve Ciğerlioğlu (2018)	2002-2016 (Turkey)	Exploratory spatial data analysis	It has been determined that there is a positive relationship between industrial production and economic growth, indicating that as industrial production increases, it contributes positively to the overall economic growth.
Tang (2020)	1965-2016 (Chinese)	Time series analysis	Industrialization and financial development are catalysts for economic growth, driving it through their broader economic impacts.
Ciccarelli & Fanchin (2017)	1871-1911 (Italy)	Time series analysis	In 19th-century Italy, industrialization was a key driver of economic growth, influenced by changes in human and social capital.

When we look at the studies conducted by countries in general, it is supported that there is a relationship between industry and economic growth, especially in Latin America. When we look at the studies conducted in Turkey, it is generally supported that there is a relationship between industry and economic growth.

3. Economic Methodology and Dataset

3.1. Dataset

As can be seen in the literature, studies examining the empirical relationship between economic growth and industrialization and industrial production through panel analysis yield various results depending on the level of development of countries, and according to the studies, both unidirectional and bidirectional interactions are observed between economic growth and industrial production. The main objective of this study is to analyze the relationship between economic growth and the industrial sector in depth by

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conducting panel analysis on the quarterly data of Kyrgyzstan, Kazakhstan and Russia between 2000:1 and 2021:4.

Variable	Description	Period, Type	Source
GDP	Economic Growth Index	Quarter, Dollar (US)	The Interstate Statistical Committee of the Commonwealth of Independent States (CIS STAT)
IPI	Industry Index	Quarter, Dollar (US)	

The relationship between industrial production and economic growth is analyzed using data for Kyrgyzstan, Kazakhstan and Russia covering the period between 2001:1 and 2021:4.

3.2. Econometric Methodology

3.2.1. Panel Unit Root Tests

Panel unit root tests are tests that consider the information of the data formed by the combination of time and cross-sectional dimensions. Therefore, it is accepted that they provide statistically stronger and more significant results than unit root tests using time series. The reason for this is that the inclusion of the horizontal cross-sectional dimension in the analysis process allows the number of variations in the data to increase (Hurlin and Mignon, 2007:2).

The tests produced by Levin and Lin (1992,1993) and Quah (1994) have played an important role in panel data unit root studies. There have been significant developments in the investigation of integrated series in panel data and with these developments, panel unit root tests have started to be applied in different fields (Hurlin and Mignon, 2007:2).

In econometric analyses, the process of whether the series is stationary in time is tested first. The reason for starting with this step first is to ensure that the series with a trended structure called spurious regression do not give misleading results, that is, the results of traditional t, F tests and R2 values are not deviated (Tatoğlu, 2013:199).

Adding a cross-sectional dimension to a time series that does not follow a stationary process is important in terms of sample size. The discriminative power of a small sample size for testing the stationarity process of a time series is low. Therefore, it is important to increase the number of observations to increase the predictive power of unit root tests. The use of panel data will contribute to the solution of the problem of small sample size in unit root tests since the addition of time and cross-sectional dimension to the series will increase the number of observations (Hurlin and Mignon, 2007:3). The main problem encountered in panel unit root test analyses is to determine whether the sections that make up the panel data are independent of each other. To solve this problem, panel unit root tests have started to be analyzed under two main headings as first and second generation. First-generation tests are divided into homogeneous and heterogeneous models under the assumption that there is no correlation between the units. Levin et al. (2002), Hadri (2000) and Breitung (2005) are based on the homogeneous model assumption, while Maddalla et al. (1999), Choi (2001) and Im et al. (2003) are based on the heterogeneous model assumption. The main feature of the second-generation panel unit root tests is the

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assumption that there is a correlation between the series of the units. Examples of these tests are Peseran (2004), Bai and Ng (2004), Philips and Sul (2003), Moon and Perron (2004) panel unit root tests (Hurlin and Mignon, 2007).

3.2.2. Levin, Lin and Chu (LLC) Panel Unit Root Test

Levin, Lin and Chu (2002) argued that individual unit root tests have limited power against alternative hypotheses with excessively persistent deviations from equilibrium. This becomes particularly important in small samples. LLC proposes a more powerful panel unit root test that allows the application of different unit root tests for each cross-section. The null hypothesis is that each time series contains a unit root, while the alternative hypothesis is that all time series in the panel are stationary (Baltagi, 2005:240).

The hypotheses in this test are as follows:

H_0: There is a general unit root process in each series in the panel (H0: pi = p = 1).

H_1: There is no general unit root process in each series in the panel (H1: pi = p<1).

Model 1: $$\Delta Y_{it} = pY_{it-1} + u_{it} \quad (1)$$

Model 2: $$\Delta Y_{it} = \alpha_{oi} + pY_{it-1} + u_{it} \quad (2)$$

Model 3: $$\Delta Y_{it} = \alpha_{oi} + \alpha_{1it} + pY_{it-1} + u_{it} \quad (3)$$

Model 1 is the homogeneous panel process; Model 2 is the heterogeneous panel process with a fixed parameter and Model 3 is the heterogeneous fixed and individual trends process. For simplicity, the following basic equation is constructed based on Model 2.

$$\Delta Y_{it} = pY_{it-1} + \sum_{L=1}^{p_i} \theta_{iL} \Delta Y_{it-L} + \alpha_{mi} d_{mt} + u_{it} \quad (4)$$

Here u_{it}, too, there is no correlation across units, and it follows an Autoregressive Moving Average (ARMA) process.

$$u_{it} = \sum_{j=1}^{\infty} \theta_{ij} V_{it-j} + \varepsilon_{it} \quad (5)$$

In equation 4, d_{mt} denotes dummy variables for each unit and α_{mi} denotes their parameters. First, separate regressions of ΔY_{it} and ΔY_{it-1} on ΔY_{it-L} are calculated and the residual results are obtained separately.

$$e_{it} = \Delta Y_{it} - \sum_{L=1}^{p_i} \pi_{iL} \Delta Y_{it-L} - \alpha_{im} d_{mt} \quad (6)$$

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$$u_{it-1} = \Delta Y_{it-1} - \sum_{L=1}^{p_i} \pi_{iL} \Delta Y_{it-L} - \alpha_{im} d_{mt} \qquad (7)$$

To remove the heterogeneity arising from the units in the cross-sectional data, the residuals from the above equations are normalized by the ratio to the standard error of the main equation as follows.

$$e_{it} = \frac{e_{it}}{\sigma_{e_i}} \quad \text{ve} \quad u_{it-1} = \frac{u_{it-1}}{\sigma_{e_i}} \qquad (8)$$

In the next stage, long-run and short-run standard deviations are estimated. The long-run standard deviation is expressed by the following formula:

$$\sigma_{Y_i}^2 = \frac{1}{T-1}\sum_{t=1}^{T} \Delta Y_{it}^2 + 2\sum_{L=1}^{K} \omega_{KL} - \left[\frac{1}{T-1} \sum_{t=2+L}^{T} \Delta Y_{it} \Delta Y_{it-L} \right] \qquad (9)$$

Here $\bar{K}$ is the discrete lag depending on the data and $\omega_{KL} = 1-(L/(K+1))$ is the equation.

The standard deviation for each cross-sectional unit is calculated by dividing the long-run standard deviation result by the short-run standard deviation result.

$$S_i = \sigma_{Y_i} / \sigma_{e_i} \qquad (10)$$

and the mean standard deviation (S_N) statistic is calculated as follows.

$$S_N = \frac{1}{N}\sum_{i=1}^{N} S_i \qquad (11)$$

This value is used in the calculation of adjusted t statistics.

$$t_p^* = \frac{t_{p=0} - (NT) S_N \sigma_\varepsilon^{-2} se(\alpha) \mu_{mT}^*}{\sigma_{mT}^*} \qquad (12)$$

Here, μ_{mT}^* and σ_{mT}^* are the mean and standard deviation correction parameters obtained from Monte Carlo simulations. The test statistics are compared with the results of LLC (2002) table values and if the null hypothesis is not accepted, it is concluded that each series in the panel does not follow a unit root process, i.e. it is stationary (Baltagi, 2005:240-241& Tatoğlu, 2013:200-201).

To apply the LLC (2002) panel unit root test, the series should form a balanced panel. This test is based on the t test. The mean and standard variance of the asymptotic t statistic depend on the deterministic specification of the model. The Levin, Lin and Chu test is designed for a range of 10 to 250 units (N:10-250) and 25 to 250 observations per unit (T:25-250) (Tatoğlu, 2013:202).

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3.2.3. Causality Concept and Dumitrescu & Hurlin Granger Causality Analysis

Regression analysis reveals dependency relationships between variables, but these relationships do not necessarily indicate a causal relationship. In causality analysis, the direction of these relationships is examined without a prerequisite for separating variables into dependent and independent. The causality relationship can be determined by using economic theory and causality tests with Granger tests developed by different authors. Long-run time series should be stationary, whereas in causality testing, factors such as sample size, data structure and lagged variables are important for Granger causality testing (Tarı, 2012).

The main reason for conducting Granger causality tests within the panel data framework is the desire to benefit from the advantages of panel data models due to their structure. Panel data allows modeling the behavior of units in a more flexible way than traditional time series analysis, and since it contains more observations than a single time series, it leads to more efficient results than Granger tests in the traditional context, especially in short time periods (Hood et al., 2008). As stated by Dumitrescu and Hurlin (2012), a causal relationship that is valid for one country in terms of any economic phenomenon is likely to be valid for other countries. Therefore, the causality relationship can be tested more efficiently with more observations in the panel data framework.

The existence of horizontal cross-sectional information requires the consideration of heterogeneity across units in panel Granger causality analysis. Holtz-Eakin et al. (1988) tested the null hypothesis that there is no causal relationship between the variables of all units against the alternative hypothesis that there is a causal relationship between the variables of all units. In other words, the null hypothesis of no homogeneous Granger causality was tested against the alternative hypothesis of homogeneous Granger causality. Due to these homogeneous hypotheses, the hypothesis that Granger-causality is not valid for all horizontal cross-sections can be rejected and the hypothesis that this relationship exists in all horizontal cross-sections can be accepted, while there is a causality relationship in only a subgroup of the sample. This problem is overcome with the panel Granger causality test introduced by Dumitrescu and Hurlin (2012). In the Dumitrescu and Hurlin panel Granger causality test, the absence of a homogeneous Granger causality relationship under the null hypothesis is tested against the alternative hypothesis that this relationship exists in at least one horizontal cross-section.

3.3. Analysis Results

In this study, the data of Kyrgyzstan, Russia and Kazakhstan countries are used. Industrial index and economic growth index data for the period between 2000:1 and 2021:4 is obtained from cisstat.com. First, the data are seasonally adjusted. The graph of the data is given below.

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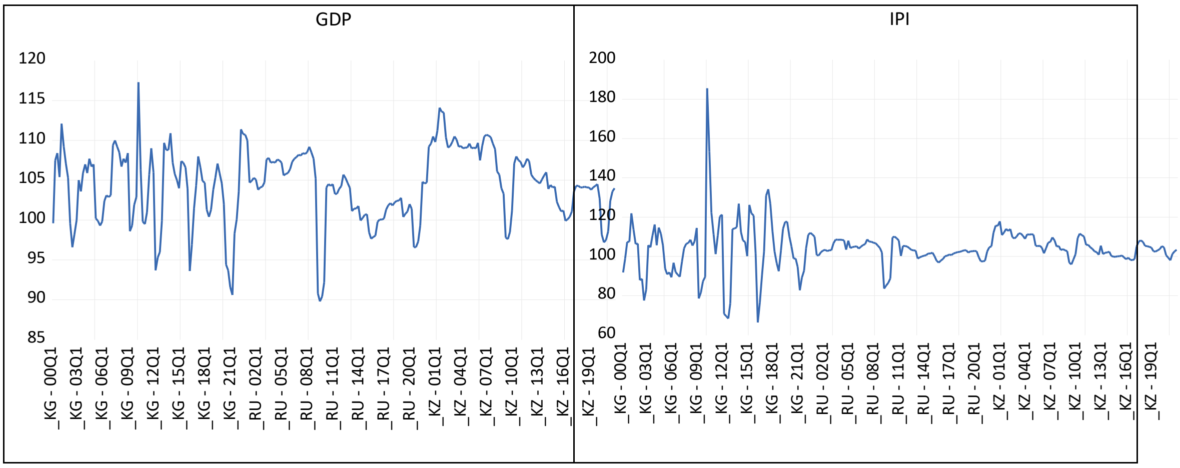
Graph 1. GDP and Industrial Index



Seasonally adjusted data are used to analyze the effects of the industrial sector on economic growth more clearly. The obtained data are subjected to detailed statistical analysis to understand the relationship between economic growth and industrial production. In this process, various methods were applied to improve the reliability and validity of the data and seasonal fluctuations in the data were minimized. It provides a comprehensive review of the relationship between the industrial index (IP) and the economic growth index (GDP) for the analyzed period.

Table 3. Levin, Lin & Chu t* Test Results

LLC Test	Model with constants	Model with Constant and Trend	Model without constants
IPI I~ (0)	-2,9923***	-2,6262***	-0,8023
Growth I~ (0)	-2,0635***	-2,0794***	-0,6302

Note: ***, **, * at 1%, 5%, 10% significance level, respectively

According to the results of the panel unit root analysis, the data are stationary as seen above. More specifically, economic growth and industrial index are stationary at 1% significance level. The data are not stationary in the model without constant and trend. However, as can be seen in the graphs, the data are in the model with constant and trend. Therefore, the data are considered to have no unit root and are directly used in causality analysis.

After the stationarity tests, the optimal lag length of the data will be determined. A tabulated version of the optimal lag length is given below.

Table 4. Optimal Lag Detection Test Results

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1.549.794	NA	1.416.387	1.293.162	1.296.062	1.294.331
1	-1.324.754	4.444.553	2.244.968	1.108.961	1.117.663	1.112.467
2	-1.307.154	3.446.597	2.004.451	1.097.628	1.112.131	1.103.472
3	-1.300.270	1.336.688	1.956.889	1.095.225	1.115.528	1.103.406

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4	-1.292.994	1.400.656	1.904.258	1.092.495	1.118.599	1.103.013
5	-1.272.094	3.988.418	1.654.199	1.078.411	11.10317*	10.91267*
6	-1.269.237	5.403.333	1.670.179	1.079.364	1.117.071	1.094.557
7	-1.265.375	7.241.202	1.672.292	1.079.479	1.122.987	1.097.010
8	-1.259.699	10.54899*	164.9336*	10.78082*	1.127.391	1.097.950

When the optimal lag is determined, the SC criterion is taken as the basis and the optimal number of lags is set as 5.

Table 5. Granger Causality Test Results

Dependent variable	Direction of Causality	F statistic
Economic Growth Index	Industry Index $\Rightarrow$ Economic Growth Index	52,7587 (0,000)
Industry Index	Economic Growth Index $\Rightarrow$ Industry Index	28,5836 (0,000)

According to the causality test results, a bidirectional causal relationship was found. In other words, in the country groups used in the analysis, economic growth is the cause of changes in the industrial sector or vice versa. According to these test results, if economic growth is planned, the objectives can be achieved with the development in the industrial sector.

Table 6. Dumitrescu & Hurlin Granger Causality Test Results (X=GDP, Y=IPI)

	Zbar statistic	Probability Value
cross unit identifier: 1 (KG)	89.613	0.1106
cross unit identifier: 2 (RU)	283.607	0.0000
cross unit identifier: 3 (KZ)	22,4135	0.0004

According to the unit causality test result, when the optimal lag length is 5, a causality relationship from the economic growth index to the industrial index is detected in Russia and Kazakhstan at 1% confidence interval. There is no causality relationship from economic growth index to industrial index in Kyrgyzstan.

Table 7. Dumitrescu & Hurlin Granger Causality Test Results (X=IPI, Y=GDP)

	Zbar statistic	Probability Value
cross unit identifier: 1 (KG)	20,9627	0.0008
cross unit identifier: 2 (RU)	13,8525	0.0166
cross unit identifier: 3 (KZ)	4,9373	0.4236

There is no causality relationship from the independent variable, the industrial index, to the growth index for Kazakhstan. However, there is a causality relationship in the same direction for Russia at 5% confidence interval. In Kyrgyzstan, it is concluded that there is causality from the industrial index to the growth index at 99% probability value.

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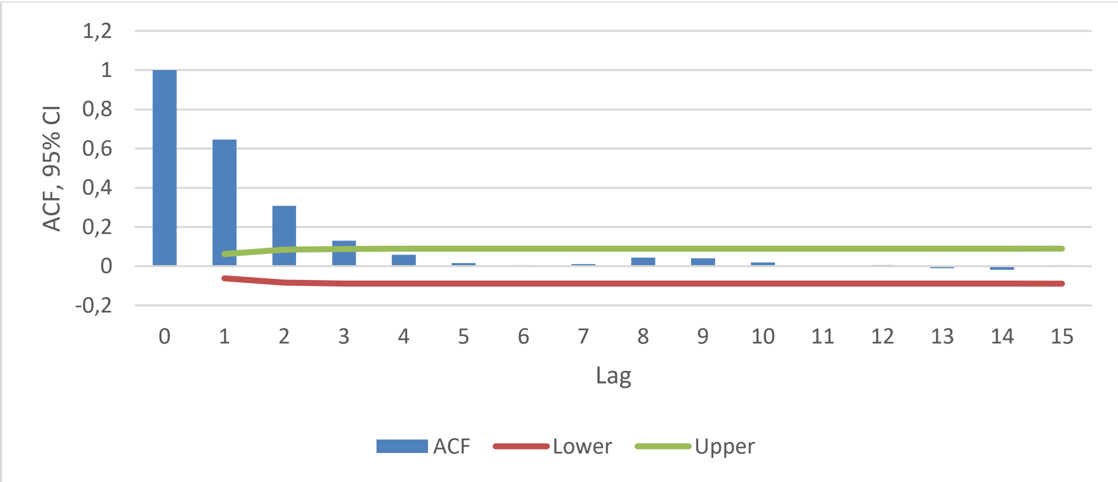
A VAR model has been established in the context of Gross Domestic Product and Industrial Index in Russia, Kazakhstan and Kyrgyzstan. The autocorrelation results of this VAR model will also be evaluated below. The VAR model is as follows:

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + \cdots + A_p y_{t-p} + \varepsilon_t \quad (13)$$

Here y_t represents the sub-variable. The number of lags of the model is determined by (AIC) and chosen as p=2.

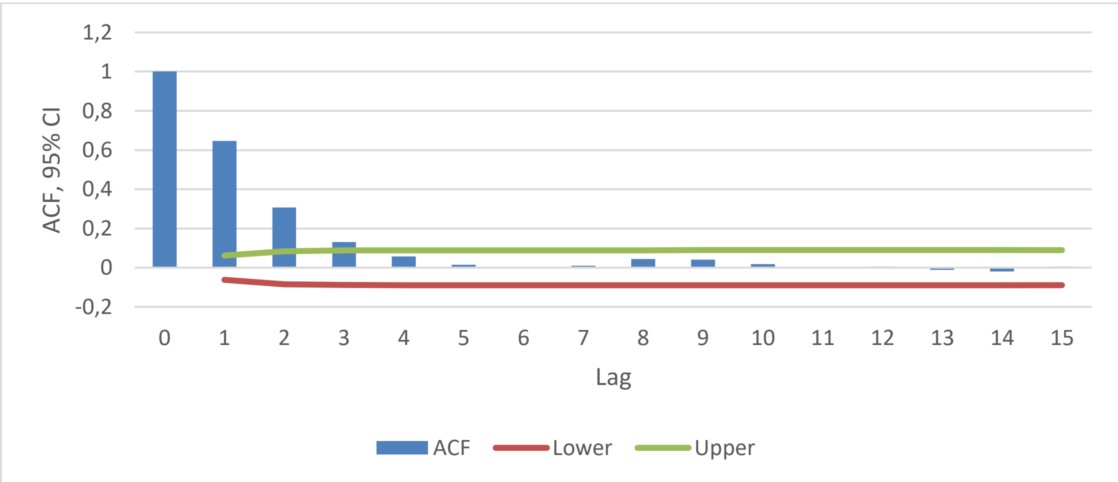
Graph 2 shows the Autocorrelation Function. The ACF plot shows the autocorrelation of the residuals.

Graph 2. Autocorrelation Function Graph



Graph 3 shows the Partial Autocorrelation Function. The PACF plot shows the partial autocorrelation for each lag. Significant values are found in the first three lags.

Graph 3. Partial Autocorrelation Function Graph



According to Table 8, there is a significant autocorrelation between GDP and industrial index in Kazakhstan at lag 1. It shows that changes in GDP affect industrial production.

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In Russia, autocorrelation is significant at lag 2. GDP contributes to economic growth by affecting the industrial index. In Kyrgyzstan, autocorrelation is high at lag 3.

Table 8. Ljung-Box Autocorrelation Test Results

Lags	Test Statistic	P-value
1(KZ)	6.12	0.013
2(RU)	9.74	0.024
3(KG)	11.45	0.008

The results show that there is a significant autocorrelation between GDP and Industrial Index in Russia, Kazakhstan and Kyrgyzstan. This shows that the GDP values in the past period have had an impact on the current industrial index and thus economic growth has a strong relationship with industrial production.

4. Conclusion

Generally, studies examine the empirical relationship between economic growth and industrial production using panel analysis and yield different results depending on the level of development of countries. Studies show both unidirectional and bidirectional interaction between economic growth and industrial production. The aim of this study is to analyze the relationship between economic growth and the industrial sector in 3 selected countries. A panel analysis of the quarterly data of Kyrgyzstan, Kazakhstan and Russia for the periods 2000:1, 2021:4 was conducted. First, the unit root test is tested and then causality tests are performed. The data used in the analysis were found to be stationary at the level. In other words, crises are not permanent at the series level. The optimal lag of the data to be tested in the next stages was found. The optimal lag was determined according to the SC criterion. In the next stage, analysis was applied. According to Granger causality analysis, a bidirectional causal relationship was found. This result also supports the results of Kaldor's (1966) analysis. Dumitrescu-Hurlin unit test is tested as a unit causality analysis. According to the results of the unit test, it is concluded that the economic growth index is the cause of the industrial index in Russia and Kazakhstan with a confidence interval of 99%. There is no causality relationship from the independent variable industrial index to the dependent variable growth index for Kazakhstan. For Russia, there is a causality relationship between the industrial index and the growth index at a confidence interval of 5%. At a confidence interval of 1%, it is concluded that there is a causality from the industrial index to the growth index at a probability value of 99%. There is a significant autocorrelation between GDP and the industrial index in all three countries. This suggests that past economic performance affects the current situation. The results reveal that increases in GDP have a positive impact on the industrial index and emphasize that economic growth is strongly correlated with industrial production. In short, the development and support of the industrial sector in developing countries such as Kazakhstan and Kyrgyzstan and developed countries such as the Russian Federation is of great importance for the economies of the countries.

Based on these results, if countries aim for economic growth, they need to develop the industrial sector. Direct or indirect policies can be implemented to develop the industrial

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sector. Directly, it can use its resources in an optimum way by investing in the industrial sector, subsidies, creating industrial zones, and R&D expenditures. Indirectly, tax policies can contribute to the development of the industrial sector. In addition, the effects of domestic and foreign policies of countries on these two variables should be taken into consideration. For example, improving trade policies and the foreign investment climate can increase industrial production and positively affect GDP. If the amount of production in the industrial sector increases, it indicates that more people will be employed in the economy. As the total demand for goods and services will increase with the increase in employment, there will be an increase in the number of investments in the economy. This will accelerate economic growth. First, the fact that Russia is in a different situation than other Central Asian countries, both in terms of industrialization and geopolitical reasons, requires that this country should be considered exclusively. The results of the analysis also support this situation. The view that Russia will be able to achieve a high economic growth rate with the development of industrialization is highly debated. If Russia wants to realize a high sustainable growth rate in the future, the industrial sector, especially the manufacturing sector, is expected to play a driving role in this growth. With competitive industrialization policies supported by technological investments, Russia can succeed in industrialization and economic growth, and industrialization can reduce Russia's high dependence on the agricultural sector. Kazakhstan's growth performance in recent years, and the reason why industry is not the main reason, is due to the success of non-industrial sectors. However, sustainable growth has more to do with industry than with exhaustible underground resources. Therefore, it is recommended that Kazakhstan should focus on the industrial sector to achieve sustainable growth and make its economic growth performance much more successful. The fact that there is an interaction from economic growth to industry in Kazakhstan will accelerate this process. In this sense, since Russia has an industry-driven result and Kazakhstan has a growth-driven result, it is considered by us that new industrial policies should be implemented in Russia to increase the incentive for industry and in Kazakhstan to implement new industrial policies. The fact that Kyrgyzstan has different and more limited resources than Russia and Kazakhstan have led to different analysis results from these countries. Kyrgyzstan, on the other hand, is recommended to rapidly adopt a production economy, pave the way for foreign investments, and give due importance to the industrial sector to transform the import-dependent growth into real growth as soon as possible. Since there is an interaction from industry to growth in Kyrgyzstan, developments in industry will directly affect economic growth and welfare level. Thus, Kyrgyzstan will be prevented from remaining relatively behind among the Central Asian countries.

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