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Analysis of the Effects of Energy Consumption, Employment, Mining, Natural Resource Income, and Foreign Direct Investments on Economic Growth in the Central Asian Turkic Republics Using Panel Causality Tests

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ABSTRACT

This study examines the impact of energy consumption, employment, mining and natural resource revenues, and foreign direct investments on economic growth in the Central Asian Turkic Republics, specifically Azerbaijan, Kazakhstan, Kyrgyzstan, Turkmenistan, and Uzbekistan. A panel data analysis was conducted using annual data covering the period from 1993 to 2023. The relationship between the variables was investigated using the Dumitrescu-Hurlin panel causality test, while the Hsiao homogeneity test confirmed that the series were homogeneous. The findings indicate that foreign direct investments (FDI) have a one-way causal effect on economic growth and that these investments also lead to increased energy consumption. Conversely, no direct impact of energy consumption, employment, or natural resource revenues on economic growth was observed. While periodic fluctuations in energy consumption and natural resource revenues were noted among the countries, economic growth exhibited a more stable trajectory, particularly after 2000. These results highlight the critical role of foreign direct investments in fostering sustainable growth and underscore the importance of channeling these investments into the production sector. It is recommended that policymakers devise long-term strategies for energy and investment that will promote economic stability and growth.

Keywords: Hsiao Test, Dumitrescu Hurlin Panel Causality Test, Foreign Direct İnvestments, Energy Consumption, Gross Domestic Product
JEL Classifications: C13, C20, C22

1. INTRODUCTION

With the end of the Cold War and the dissolution of the Soviet Union in 1991, Azerbaijan, Kazakhstan, Uzbekistan, Kyrgyzstan, and Turkmenistan gained independence and underwent significant transformations in their political and economic structures. The transition from a planned economy to a free-market economy required the adoption of new policies and the implementation of economic reforms in these countries. The primary goal during this adaptation process was to ensure integration with the global economic system, enhance the welfare of the people, and establish economic structures that support sustainable growth (Niyetalina et al., 2023). The countries adopted different strategies depending on their natural resources and industrial infrastructures. For instance, the economic growth policies of Kazakhstan and Azerbaijan are largely centered around oil and natural gas exports, while Turkmenistan's economic development model is based on its natural gas resources. Uzbekistan aimed to increase economic

diversity through the production of natural gas, oil, and gold. Kyrgyzstan's economic growth primarily relies on gold mining and remittances from citizens working abroad (Syzdykova, 2019). However, these nations face challenges due to fluctuations in global energy prices because of their heavy dependence on oil and natural gas for export revenues.

After gaining independence, Azerbaijan implemented significant structural reforms as part of its transition to a free market economy. However, conflicts in the Nagorno-Karabakh region have adversely affected the country's economic development. Azerbaijan possesses approximately 0.6% of the world's oil reserves and 2.5 trillion cubic meters of natural gas reserves, which play a central role in the country's economic growth (Süleymanov and Hasanov, 2013; Şahin and Konak, 2019; Yesbolova et al., 2024).

Kazakhstan also pursued structural reforms during its transition to a free-market economy and navigated this process relatively swiftly due to its abundant natural resources. The country holds 3% of the world's oil reserves and 1.1% of natural gas reserves, and it ranks second globally in uranium reserves. Thanks to the economic reforms and investments made, Kazakhstan has become the country with the largest GDP among the Commonwealth of Independent States (CIS) after Russia (Mudarissov and Lee, 2014; Xiong et al., 2015; Kelesbayev et al., 2022; Bekzhanova et al., 2023; Sabenova et al., 2024; Sultanova et al., 2024).

Kyrgyzstan is the Central Asian country with the most limited energy resource opportunities, and its economic growth predominantly relies on hydroelectric power generation and remittances from citizens working abroad (Köse, 2020). Nevertheless, it quickly implemented reforms during its transition to a free-market economy, becoming the first Central Asian country to join the World Trade Organization (Yesbolova et al., 2024).

Following its independence, Turkmenistan undertook comprehensive reforms aimed at ensuring economic stability during its transition to a market economy. As one of the richest countries in the world in terms of natural gas reserves, Turkmenistan views these resources as the cornerstone of its economic growth (Köse, 2020; Yesbolova et al., 2024).

Unlike other Central Asian countries, Uzbekistan has pursued economic reforms gradually. While it may not possess as many energy resources as Kazakhstan and Azerbaijan, Uzbekistan aimed to diversify its economy by focusing on gold and uranium production. Additionally, the country has strengthened its financial system through collaboration with global institutions like the World Bank, IMF, and the European Bank for Reconstruction and Development (Putz, 2017; Syzdykova, 2018; Yesbolova et al., 2024).

Over the 30 years since gaining independence, these Central Asian nations have made significant strides in economic growth, foreign trade volume, and living standards, even in the face of global economic crises. The increase in GDP and improvements in welfare since the 2000s highlight the positive outcomes of these reforms (Syzdykova, 2019). However, economic growth models reliant on energy resources come with vulnerabilities due to fluctuations in global market prices.

Economic growth refers to the process of enhancing a country's production capacity and utilizing its resources more efficiently. Key components of this process include labor, natural resources, capital accumulation, foreign trade policies, and financial structures (Neelankavil et al., 2012; Aidarova et al., 2024). The most commonly used metric to assess economic growth is Gross Domestic Product (GDP) (Dyussembekova et al., 2023). While GDP measures the total value of goods and services produced over a specific period, nominal and real calculations provide different analytical insights. Globalization and technological advancements have elevated the significance of economic growth, becoming critical factors that influence nations' competitiveness and welfare (Sartbayeva et al., 2023; Issayeva et al., 2023; Abdibekov et al., 2024; Ibyzhanova et al., 2024; Lukhmanova et al., 2025).

The relationship between energy consumption and economic growth has garnered increasing attention, particularly concerning developing economies. Generally, there is a strong correlation between economic growth and energy consumption. As economic activity expands, the demand for energy typically increases, leading to higher energy consumption (Acheampong et al., 2021). Studies, including those by Shahbaz et al. (2016), Sadorsky (2010), and Destek (2018), have demonstrated that economic growth in developing countries is closely tied to rising energy consumption. However, some research suggests the opposite, indicating that economic growth might reduce energy consumption due to enhanced energy efficiency. For example, Rafiq et al. (2016) concluded that economic growth could lead to a decrease in total energy consumption by improving energy efficiency. Moreover, the literature reveals varying results regarding the causal relationship between energy consumption and economic growth. In certain countries, a unidirectional causality from energy consumption to economic growth has been identified, while in others, the relationship may be bidirectional or even in the opposite direction. These differences often depend on factors such as a country's economic structure, energy policies, and levels of industrialization (Acheampong et al., 2021). Therefore, it is essential to consider country-specific dynamics to understand how energy consumption impacts economic growth.

The relationship between employment and economic growth has been a significant topic of discussion and research in economic literature for many years. Generally, it is accepted that economic growth contributes to an increase in employment, as demand for labor tends to rise with expanded production (Cheng, 2024). Keynesian economic theory posits that an increase in aggregate demand raises the need for labor and encourages full employment, while the Harrod-Domar model suggests that sustainable economic growth is achieved through investment and job creation (Cheng, 2024). However, it has been observed that in many developing countries, the capacity for high growth rates to create employment is limited, leading to a phenomenon known as "jobless growth" (Haider et al., 2023). In their analysis using the Cobb-Douglas production function, Haider et al. (2023) found that employment

elasticity in developed countries ranges from 0.43 to 0.48, whereas in developing countries it varies from 0.11 to 0.15. This discrepancy highlights that the potential for economic growth to create jobs is affected by the country's specific context. Consequently, there is an emphasis on the need for employment-oriented growth policies in developing nations (Haider et al., 2023).

Foreign direct investment (FDI) has emerged as an important area of research due to its impact on economic growth. The prevailing view is that FDI fosters economic growth through mechanisms such as capital accumulation, technology transfer, and productivity improvements. Particularly in developing economies, evidence suggests that FDI not only enhances investment levels, helping to bridge the capital gap but also boosts productivity via total factor productivity (Le et al., 2024). However, the literature does not reach a consensus regarding the relationship between FDI and economic growth. Some studies indicate that FDI has direct positive effects on economic growth (Le et al., 2024), while others argue that this effect is contingent on factors such as the macroeconomic stability of the host country, the level of human capital, and the development stage of its financial markets (Joo and Shawl, 2023). For instance, Borensztein et al. (1998) found that FDI only stimulates growth in countries with a sufficiently developed level of human capital. Similarly, Alfaro et al. (2004) demonstrated that well-developed financial markets enhance the positive influence of FDI on economic growth. Additionally, some studies suggest that the impact of FDI on economic growth can change over time. Bénétrix et al. (2023) discovered that the relationship between FDI and economic growth has evolved with the transformation of global value chains since the 1990s, indicating that this relationship is not always stable (Bénétrix et al., 2023). It is also noted that in some instances, FDI may negatively affect competitiveness by undermining local industries (Le et al., 2024). Thus, the effect of FDI on economic growth is highly dependent on the structural conditions of the host country and the economic dynamics of the period.

This study will analyze the effects of energy consumption, employment, and foreign direct investment on economic growth in the Central Asian Turkic republics using the Panel Causality test. The research data were obtained from https://ourworldindata.org and cover the period from 1993 to 2023.

2. LITERATURE REVIEW

The academic literature reveals that numerous empirical studies have been conducted on the effects of energy consumption, employment, and foreign direct investment (FDI) on economic growth, utilizing various statistical methods across different countries and groups of countries. Given the extensive nature of this research, it would suffice to highlight a selection of relevant studies pertaining to this topic.

Haider et al. (2023) explored the relationship between employment and economic growth in both developed and developing countries during the period from 1970 to 2019. Addressing the issue of "jobless growth," which is frequently discussed in the literature, they tested the hypothesis that the employment-generating capacity of economic growth is significantly higher in developed countries compared to developing countries. The researchers employed an employment demand model based on the Cobb-Douglas production function and analyzed employment elasticity alongside factors such as working hours and population. They utilized the Westerlund cointegration test and advanced panel data analysis methods to examine long-term relationships. The results indicated low employment elasticity (0.11-0.15) in developing countries, highlighting a high probability of rising unemployment in these regions. In contrast, the elasticity of employment in developed countries was found to be higher (0.43-0.48). Among their policy recommendations, the researchers emphasized the need for developing countries to focus on employment-oriented growth strategies rather than economic growth-focused employment strategies.

Cheng (2024) investigated the interrelationship between employment and economic growth in his study. The article reviews existing literature and underscores the crucial role of economic growth in influencing employment and vice versa. Using China as a case study, Cheng examined the underlying reasons for low employment rates despite high economic growth. The study discusses the impacts of government policies, technological advancements, and an unbalanced industrial structure on this phenomenon. Literature review and causal analysis served as the primary methodologies for the research. Cheng also provided policy recommendations, including transforming the role of government, promoting employment-friendly technologies, and enhancing the industrial structure.

In their research, Le et al. (2024) examined the relationship between foreign direct investment (FDI), total factor productivity (TFP), and economic growth specifically in middle-income countries. They utilized an unbalanced panel dataset comprising 2,714 annual observations covering 90 middle-income countries from 1990 to 2020. The effects of FDI and TFP on economic growth were analyzed using the dynamic system Generalized Method of Moments (GMM). The findings revealed that FDI boosts economic growth by 9.3%, while TFP enhances growth through improvements in labor quality and production innovations. Additionally, TFP was found to strengthen the positive relationship between FDI and economic growth. The study supports economic growth and industrialization theories while contradicting labor market dynamics theories by offering policy recommendations for sustainable economic development.

In this study, Joo and Shawl (2023) investigated the relationship between foreign direct investment (FDI) and economic growth in developing BRICS countries - Brazil, Russia, India, China, and South Africa. Despite varying results in the literature regarding the impact of FDI on growth, BRICS nations have emerged as significant FDI destinations in recent years. The study analyzes how FDI inflows affect economic growth, considering variables such as macroeconomic stability, human capital, financial development, and trade openness. A dynamic panel Autoregressive Distributed Lag Model (ARDL) was employed using panel data from 1987 to 2018. The findings reveal a long-term cointegration relationship between FDI and economic growth.

In a different study, Acheampong et al. (2021) reevaluated the relationship between economic growth and energy consumption, considering the - economic, social, and political - effects of globalization. The analysis was based on panel data from 23 emerging economies covering the period from 1970 to 2015. The researchers utilized the Generalized Method of Moments with Instrumental Variables (IV-GMM) to explore the causality and cointegration relationships among the variables. The results indicate that energy consumption and economic growth are mutually dependent. Furthermore, economic and political globalization tend to slow down growth, while social globalization promotes growth. The study also identifies a U-shaped relationship between globalization and energy consumption, suggesting that globalization can hinder growth in the long term while simultaneously increasing energy consumption. It emphasizes the need for energy and growth policies that consider the impacts of globalization.

Syzdykova (2018) examined the relationship between energy consumption and economic growth in Central Asian countries - Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan. Using a 26-year panel data set from 1991 to 2016, the study found a long-term equilibrium relationship between energy consumption and economic growth through panel cointegration tests. Additionally, the Dumitrescu and Hurlin (2012) panel causality test revealed bidirectional causality between these two variables, supporting that the feedback hypothesis applies in Central Asian countries. The findings suggest that a 10% increase in energy consumption results in a 1.13% rise in economic growth. The study underscores the importance of carefully evaluating the effects of energy-saving policies on economic growth.

Adhikari and Chen (2012) investigated the long-term relationship between energy consumption and economic growth in 80 developing countries. They conducted their analysis using Panel Unit Root Tests, Panel Cointegration Tests, and the Dynamic Ordinary Least Squares (DOLS) method for the period from 1990 to 2009. The countries were categorized into upper-middle, lower-middle, and low-income groups. The results demonstrated a long-term cointegrated relationship between energy consumption and economic growth across the entire panel and within each income group. In upper-middle and lower-middle-income countries, energy consumption drives economic growth, whereas, in low-income countries, economic growth drives energy consumption. The findings highlight the necessity of increased investment in energy infrastructure and the development of long-term energy policies in developing nations.

In this study, Ibyzhanova et al. (2024) examined the impact of energy production and foreign trade volume on economic growth in the Turkic Republics. A panel data analysis method was applied using data from the period from 2000 to 2020. Unlike many other studies, this research specifically focuses on the effects of energy production and foreign trade on growth. The findings indicate that energy production has a significant and positive effect on economic growth; however, the impact of total foreign trade volume (considering both exports and imports) on growth was not found to be statistically significant. The results suggest that prioritizing energy production is essential for achieving sustainable growth in the Turkic Republics. It is recommended that future studies comprehensively analyze the influence of energy production on growth, incorporating macroeconomic variables such as industrial production, the agricultural economy, and the transportation sector.

3. METHOD

Panel unit root test: A unit root test is a preliminary step in time series analysis and is also essential for panel data analysis. Before conducting panel data analysis, it is important to examine cross-sectional dependency. This occurs when the number of time series periods (T) exceeds the number of cross-sectional units (N) (T > N). In such cases, the Breusch and Pagan (1980) LM test and the Pesaran et al. (2008) *LMadj* tests are used. When the opposite is true (T < N), the Pesaran (2004) *CDLM* test is applied, along with the Pesaran (2004) CD test. In these testing methods, the null hypothesis (H_0) states that "there is no cross-sectional dependence." Depending on the results, either first-generation or second-generation unit root tests are conducted (Baltagi, 2008).

If there is no cross-sectional dependence, the first-generation unit root tests commonly used such as Levin et al. (2002), Breitung (2005), Hadri (2000), Maddala and Wu (1999), and Choi (2001). Among the second-generation unit root tests, the most common are those proposed by Bai and Ng (2004) and Taylor and Sarno (1998) (Pesaran, 2006).

Hsiao homogeneity test: This method is used in panel data analysis to test whether individual effects (cross-sectional units) are homogeneous. Homogeneity tests are important for selecting unit root, cointegration, and causality tests, and for interpreting their results. If cross-sectional units differ in the variables analyzed, it is expected that the model coefficients will be heterogeneous; conversely, if they are similar, the coefficients are expected to be homogeneous. This study aims to determine whether other countries are similarly affected by any changes occurring in any of the Central Asian Turkic republics. The three-step hypothesis of the Hsiao test is expressed statistically as follows.

Specification Tests of Hsiao (1986)

- H_1 = Null Hypothesis: panel is homogeneous versus Alternative Hypothesis H_2
- H_2 = Null Hypothesis: H3 versus Alternative Hypothesis: panel is heterogeneous
- H_3 = Null Hypothesis: panel is homogeneous versus Alternative Hypothesis: panel is partially homogeneous.

The H_1 hypothesis tests for the general homogeneity, the H_2 hypothesis assesses the homogeneity of slopes, and the H_3 hypothesis evaluates the homogeneity of the intercept, also known as partial homogeneity (Hsiao, 2003).

The Dumitrescu and Hurlin panel causality test: one crucial aspect of panel causality tests is that they necessitate a large number

of observations. One of the key advantages of the Dumitrescu and Hurlin (2012) panel Granger causality test, which has been introduced in the econometric literature in recent years, is its ability to account for cross-sectional dependence among units. This test can be applied whether the time dimension (T) is larger or smaller than the cross-sectional dimension (N) and can yield effective results with unbalanced panel datasets (Dumitrescu and Hurlin, 2012). In the testing methodology, Wald statistics are computed for each cross-section to evaluate the hypothesis that there is no causal relationship. The average of these Wald statistics is then calculated to produce the panel-level Wald statistic.

4. DATA AND FINDINGS

When investigating the factors affecting economic growth in macroeconomic terms, it is important to consider variables such as employment, foreign direct investments, revenues from minerals and natural resources, and energy consumption, which is a vital component of production activities. This approach is significant from both economic and practical perspectives. This study will analyze the relationships among employment, energy consumption, revenue from minerals and natural resources, foreign direct investments, and economic growth in the Central Asian Turkic republics, which share similarities both economically and sociologically. Causality analysis represents a specific case of the relationships between these variables. Establishing a causal relationship between two variables implies a time sequence and supports the interpretation of a cause-and-effect relationship. The research data were obtained annually from https://ourworldindata.org for the years 1993-2023. Table 1 includes the research variables, their brief definitions, and data sources.

Table 2 presents descriptive statistics for energy consumption from primary sources by country. Analyzing the mean statistic reveals that Kyrgyzstan is the only country with a negative change in energy consumption. However, according to the median statistics, all countries show a positive change. Again, according to average statistics, Kyrgyzstan had the lowest change in energy consumption, while Turkmenistan experienced the highest change. The overall average among the five countries was 1.13. While Kyrgyzstan has the lowest change in energy consumption based on the mean, Azerbaijan exhibits the smallest change when assessed using the median. The overall average for the five countries is 1.13. Despite Kyrgyzstan's average energy consumption change being negative, Azerbaijan ranks lowest according to the median statistic. The skewness statistic for all countries falls between -1 and +1, indicating that the distribution of energy consumption change is close to the normal distribution.

Graph 1 illustrates the time path for the CPE series by country. A review of the graph indicates significant fluctuations in Turkmenistan, especially in 1996 and 2009. Overall, there is a stable time path around the mean for all countries. When considered alongside the descriptive statistics in Table 1, it can be concluded that energy consumption from primary sources in the Central Asian Turkic Republics has remained relatively unchanged over the analyzed period.

Table 3 outlines the descriptive statistics for the second research variable, Foreign Direct Investments (FDI). Both the mean and median statistics indicate that Uzbekistan and Turkmenistan have the lowest levels of foreign direct investments. Conversely, Azerbaijan stands out as the country with the highest foreign direct investments. Notably, during the analysis period, both Turkmenistan and Kazakhstan reported no years with zero or negative foreign direct investments. While Azerbaijan experienced instances of high foreign direct investments, it also had years with negative values.

Graph 2 presents the time path for foreign direct investments in the Central Asian Turkic Republics. The graph reveals that Azerbaijan experienced notably high rates of foreign direct investment between 2002 and 2006. Until 2017, all five countries exhibited a stable trend in foreign direct investments with an upper limit of 20%. However, from 2018 onwards, lower values, including negative rates for some countries, became prominent.

Table 4 details the descriptive statistics for GDP data concerning the Central Asian Turkic republics. It shows that Kyrgyzstan has the lowest average GDP, while Turkmenistan has the highest. The

Table 1: Research variables and sources

Code	Country	Variable	Description	Source
AZE	Azerbaijan	FDI	Foreign direct investment, net inflows (% of GDP)	https://ourworldindata.org
KAZ	Kazakhstan	NRR	Total natural resources rents (% of GDP)	https://ourworldindata.org
KGZ	Kyrgyzstan	CPE	Annual change in primary energy consumption (%)	https://ourworldindata.org
TKM	Turkmenistan	GDP	GDP growth (annual %)	https://ourworldindata.org
UZB	Uzbekistan			

Table 2: Descriptive statistics for the CPE variables

Country	Mean	Median	Maximum	Minimum	Standard deviation	Skewness	Kurtosis
AZE	0.483310	0.061142	13.46929	−17.99418	7.596645	−0.495885	2.937181
KAZ	0.324583	1.862598	13.55057	−17.31884	8.997177	−0.290431	1.820975
KGZ	−0.991816	0.234807	24.51556	−14.82208	8.961984	0.700866	3.498400
TKM	5.159477	5.399382	51.36654	−23.10189	17.30844	0.821215	3.779175
UZB	0.681616	0.373578	12.15893	−9.489929	4.110733	−0.015400	4.348088
ALL	1.131434	0.945115	51.36654	−23.10189	10.42782	1.223147	7.775511

overall average GDP for the five countries is 4.47. Azerbaijan is noteworthy for having both the highest and lowest economic growth values during the analysis period. The negative skewness coefficients in four of the countries, excluding Azerbaijan, suggest that these countries generally experience higher GDP values.

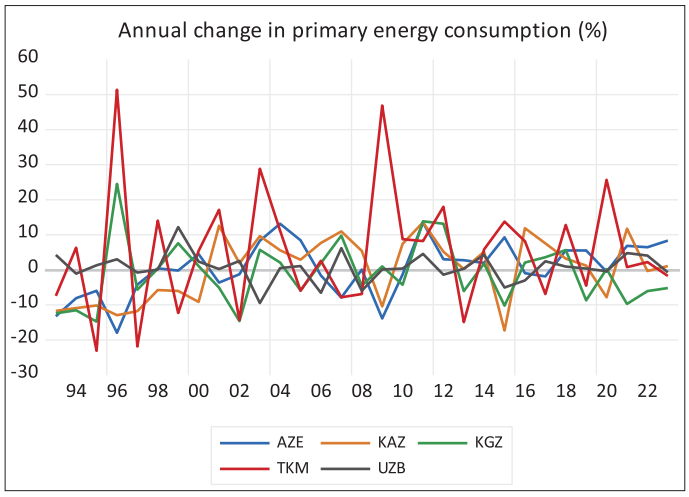
Graph 3 illustrates the time path of economic growth in the Central Asian Turkic republics. The findings reveal that, during the period until 1998-1999, there were notable instances of negative and fluctuating economic growth values. Additionally, it is important to highlight that, in 2020, all countries except Kazakhstan experienced a decline in economic growth. t is also worth mentioning that Azerbaijan had very high economic growth between 2004 and 2008. Overall, when examining the time path graph, it becomes clear that all five countries have demonstrated a generally stationary economic growth value for most of the analysis period.

Table 5 presents the descriptive statistics for mineral and natural resource income (as a ratio to GDP) by country. The data shows that Turkmenistan has the highest average income, while Kyrgyzstan has the lowest. The average income for the five countries during the analysis period is approximately 19.56. The skewness values, which fall between −1 and +1 for all five countries, indicate that mineral and natural resource incomes are normally distributed in each of the countries.

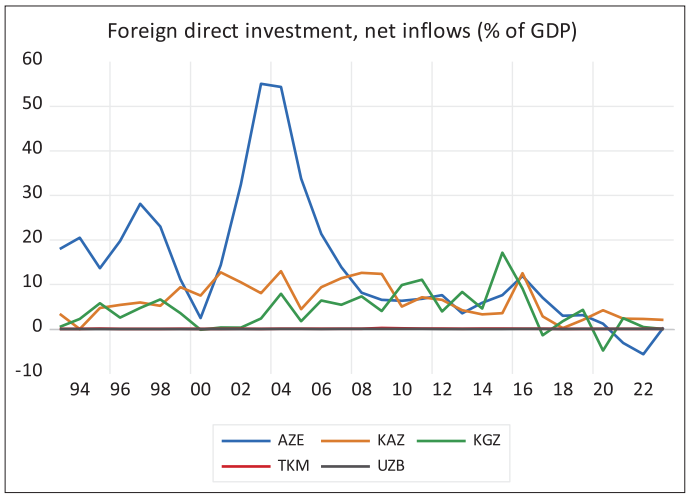
Graph 4 depicts the time path of mineral and natural resource incomes (as a ratio to GDP) by country. An analysis of the general trend reveals that all countries experienced highly fluctuating mineral and natural resource incomes (as a ratio to GDP) until 2010. Since then, a more stable income level ranging from 10% to 30% has been observed. When examining individual countries, Turkmenistan shows particularly fluctuating income levels, while Azerbaijan and Kazakhstan follow closely behind. Conversely, Kyrgyzstan stands out as the country with the most stable income throughout the analysis period.

Table 6 provides the results of the cross-sectional dependence and unit root tests for the research series. The Breusch-Pagan LM Cross-sectional Dependence test indicates the presence of cross-sectional dependence for all four variables. As a result, the CADF test method, a second-generation unit root test, was

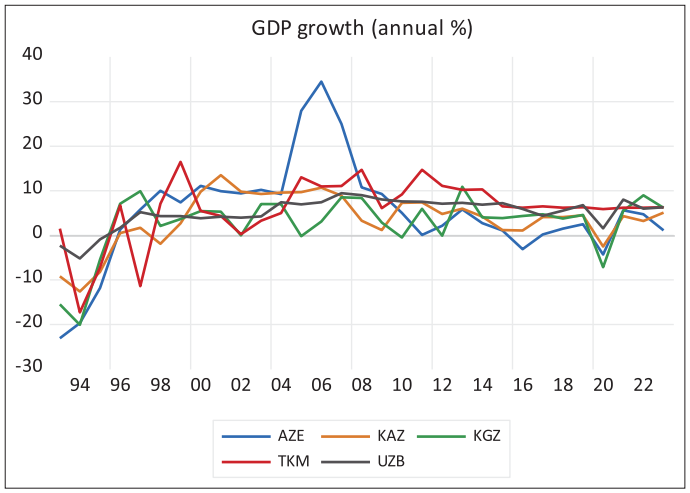
Graph 1: The time path graph for the CPE variable



Graph 2: The time path graph for the FDI variable



Graph 3: The time path graph for the GDP variable



Graph 4: The time path graph for the NRR variable

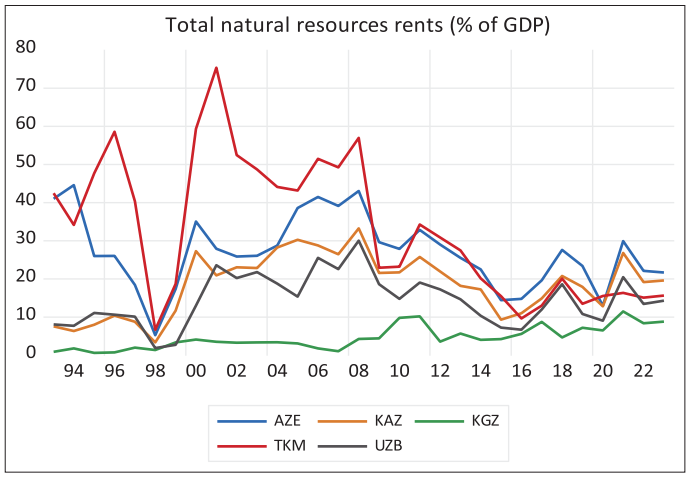


Table 3: Descriptive statistics for the FDI variables

Country	Mean	Median	Maximum	Minimum	Standard deviation	Skewness	Kurtosis
AZE	13.94206	8.161108	55.07288	−5.677737	14.60373	1.406245	4.717411
KAZ	6.273066	5.201659	13.01286	0.000188	3.960451	0.379104	1.960270
KGZ	4.147098	3.950369	17.13123	−4.854847	4.320339	0.718439	4.164245
TKM	0.063077	0.051600	0.225200	0.016600	0.042675	2.168053	8.394332
UZB	0.016023	0.012000	0.038400	−0.001800	0.010625	0.561184	2.145065
ALL	4.888264	1.743692	55.07288	−5.677737	8.642945	3.250647	16.82120

Table 4: Descriptive statistics for the GDP variables

Country	Mean	Median	Maximum	Minimum	Standard deviation	Skewness	Kurtosis
AZE	4.920697	5.048945	34.50000	−23.10000	11.49526	0.088297	4.519465
KAZ	3.664516	4.200000	13.50000	−12.60000	5.954637	−0.957097	3.813474
KGZ	2.725649	4.335856	10.91547	−20.08516	6.803212	−1.887883	6.539147
TKM	5.867942	6.300000	16.50000	−17.29986	7.119071	−1.551933	5.876010
UZB	5.157410	6.001342	9.473005	−5.200000	3.306542	−1.463442	4.950261
ALL	4.467243	5.469064	34.50000	−23.10000	7.412201	−0.561061	7.356374

Table 5: Descriptive statistics for the NRR variables

Country	Mean	Median	Maximum	Minimum	Standard deviation	Skewness	Kurtosis
AZE	27.06004	26.08857	44.59675	5.261246	9.424167	−0.004909	2.695855
KAZ	18.60029	19.62867	33.24803	3.401421	7.965509	−0.140211	1.994347
KGZ	4.604714	4.072035	11.50654	0.656133	2.991992	0.704002	2.562965
TKM	32.99691	30.87370	75.36591	6.669967	18.10320	0.409587	2.113822
UZB	14.55380	14.33911	30.05145	1.902575	6.652832	0.207133	2.590907
ALL	19.56315	17.92597	75.36591	0.656133	14.20532	1.070522	4.201711

Table 6: The cross-sectional dependence and unit root test results for the research series

Variable code	Cross-section dependence		Level		1st difference	
	t- statistics	P	t- statistics	P	t- statistics	P
CPE	20.5228	0.0247	−4.7982	<0.01	-	-
FDI	21.9027	0.0156	−2.7007	<0.01	-	-
GDP	133.8555	0.0000	−2.5926	<0.01	-	-
NRR	79.5739	0.0000	−2.1225	≥0.10	−4.9569	<0.01

Table 7: Hsiao homogeneity test findings

Hypotheses	F-statistics	P-value
H_1	0.879011	0.594302
H_2	0.744645	0.705517
H_3	1.310386	0.269018

utilized to assess stationarity. Findings indicate that the NRR variable is stationary at the first difference, while the CPE, FDI, and GDP variables are stationary at the level. Consequently, the first difference (DNRR) of the Mining and Natural Resources Income variable was employed during the analysis phase.

Table 7 presents the results of the Hsiao test, which was conducted to assess whether there was a homogeneity issue among the research series. As outlined in the methods section, the null hypothesis in the Hsiao test posits that the series are homogeneous, while the alternative hypothesis suggests that there is a heterogeneity problem between the series. The findings from the analysis indicate that the null hypothesis could not be rejected for all three of Hsiao's hypotheses. Therefore, it was concluded that the series are homogeneous.

This study examined the effects of energy consumption, employment, mining and natural resource revenues, and foreign direct investments on economic growth in the Central Asian Turkic republics using the Dumitrescu and Hurlin (2012) method, a type of panel causality test. The findings, presented in Table 8, indicate the following:

i. There is a one-way causality relationship between FDI (Foreign Direct Investment) and GDP. This means that foreign direct investments have a causal effect on GDP in the Central Asian Turkic Republics.
ii. Similarly, there is a one-way causal effect between FDI and CPE (Consumption from Primary Energy Resources). This result indicates that foreign direct investments influence energy consumption from primary resources. In other words, one of the factors contributing to energy consumption from primary resources is foreign direct investments.
iii. In other binary tests conducted to assess the presence of causality, the hypothesis of causality was rejected.

In summary, both GDP and energy consumption in the Central Asian Turkic Republics are influenced by foreign direct investments.

Table 8: The results of the pairwise dumitrescu hurlin panel causality test

Null hypothesis	W-Statistics	Zbar-Statistics	P
FDI does not homogeneously cause GDP	7.46467	4.94247	0.0000
GDP does not homogeneously cause FDI	2.39005	0.19481	0.8455
CPE does not homogeneously cause GDP	2.77665	0.55651	0.5779
GDP does not homogeneously cause CPE	2.33090	0.13948	0.8891
DNRR does not homogeneously cause GDP	3.27023	1.00180	0.3164
GDP does not homogeneously cause DNRR	3.06189	0.80851	0.4188
CPE does not homogeneously cause FDI	2.48773	0.28620	0.7747
FDI does not homogeneously cause CPE	4.68572	2.34258	0.0192
DNRR does not homogeneously cause FDI	0.91501	−1.18339	0.2367
FDI does not homogeneously cause DNRR	1.91857	−0.25227	0.8008
DNRR does not homogeneously cause CPE	1.71080	−0.44504	0.6563
CPE does not homogeneously cause DNRR	2.40377	0.19789	0.8431

5. CONCLUSION AND RECOMMENDATIONS

This study analyzed the effects of energy consumption, employment, mining and natural resource income, and foreign direct investments on economic growth in the Central Asian Turkic Republics using the Dumitrescu and Hurlin (2012) method, a panel causal analysis technique. The explanatory statistical analysis revealed the following:

i. Foreign Direct Investments were found to be at similar levels across the region, with the exception of Azerbaijan, which exhibited a lower level between 2002 and 2008.
ii. Energy consumption in Turkmenistan showed significant fluctuations.
iii. Economic growth across all countries exhibited a low (generally negative) and fluctuating trend until 1998, followed by a stable period from 1999 to 2020. The only exception to this stability was Azerbaijan, which experienced high growth from 2004 to 2008.
iv. Mineral and natural resource incomes displayed a high and fluctuating structure until 2010, after which they stabilized within the range of 10-30%.

The findings suggest that the five countries share a structure that can be generally considered similar.

According to the causality analysis, foreign direct investments play a key role in the Central Asian Turkic Republics during the analysis period. In other words, foreign direct investments are among the reasons influencing both GDP and energy consumption. Given that energy consumption is a fundamental indicator of industrial and production sector development, the critical importance of foreign direct investments for these countries is evident. Therefore, a significant recommendation for future research is to examine the impact of foreign direct investments on the industry and production sectors, as this would provide valuable insights.

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