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Energy security of the European Union and corruption in Central Asia as the main challenges for the European sustainable energy future

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Abstract

Background The main goal of the paper is to define, analyze and assess the basic security, development and institutional challenges faced by the Central Asian countries after 2022. Following the COVID-19 pandemic, and with the outbreak of the Ukrainian crisis, Europe faced problems in ensuring energy security, which were further complicated by its decision to stop importing natural gas from the Russian Federation. The Central Asian region is rich in energy resources, but at the same time, it is also a region of special geopolitical interest of often-conflicting parties, characterized by limited information and insufficient academic literature about development, various aspects of security, internal specificities and future challenges.

Methods The research included qualitative and quantitative analyses carried out for Kazakhstan, the Kyrgyz Republic, Turkmenistan, Uzbekistan, Tajikistan and Germany. Data processing was performed based on 16 selected indicators in the fields of economy, energy, governance and climate change, for the time period 2011 to 2021. Data processing was performed using correlation and regression analysis (ANOVA).

Results The results showed that corruption represents one of the biggest problems faced by the countries of Central Asia, with the biggest variations in the calculated Standardized Confidence level, which shows that this indicator trend, in relation to the 16 indicators used, is the least predictable. This represents a significant problem for all countries that are supplied with energy products from this region, or plan to do so. Energy security is positive only in the case of Turkmenistan. Regression analysis shows that Kazakhstan reported the best positive trend for most indicators. Data for Germany show consistent values over the observed period.

Conclusions The main conclusions of the paper indicate that the countries of Central Asia have certain specificities when it comes to sustainable development, where energy security, corruption and government efficiency can be considered the biggest problems. The European Union must find ways and mechanisms to overcome these and many other impediments if they decide to import energy products from the aforementioned region.

Keywords Energy security, Corruption perception, Governance effectiveness, Central Asia, Germany

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Introduction

The beginning of the third decade of the twenty-first century placed a large number of complex challenges before humanity. In addition to the existing problems of sustainable development, primarily reflected in the fight against climate change, environmental pollution, inefficient and excessive use of fossil fuels, and different determinations and commitment of individual countries and regions to sustainable development [1], the two major crises, which according to certain characteristics can be considered phenomena with the greatest global impact in the twenty-first century, have occurred. The COVID-19 pandemic has led to a severe stagnation in the world economy, created problems in supply chains and caused financial difficulties both in certain countries and at the global level [2], thus forcing individual countries to reassess their own priorities and set some new ones for the future [3]. The Ukrainian crisis broke out in February 2022 and rapidly exceeded the boundaries of the regional conflict, thus becoming a multidimensional global problem accompanied by a worrying increase in energy poverty that had existed even before the Ukrainian crisis [4]. Different countries of the world reacted differently to the Ukrainian crisis, but the introduction of the tenth and the announcement of the eleventh package of sanctions by the European Union against the Russian Federation, caused complex economic, financial, security, geopolitical and numerous other changes at the global level [5].

Bearing in mind the above, the majority of countries are looking at their own plans for sustainable development, since the financial crisis certainly limited, and in some places even gradually prevented, the financing of certain measures and activities aimed at the implementation of particular sustainable development goals [6]. When it comes to the 2018 EU Green Deal and the 2022 Recovery plan, these underwent a revision that included changes in every sense, with the diversity of views of the road to decarbonization that exist among theoreticians and practitioners [7]. However, the EU's determination for sustainable development, energy transition and decarbonization until 2050, remained unchanged [8].

The European Union has been importing energy products from different countries and regions since its inception. With increasing industrial and economic growth over the decades, imports have increased, while the type of imported energy products has changed. Although a region rich in energy resources, Central Asia has never represented a market of special interest for the European Union as a whole nor for individual countries. A small number of researches exist to clarify the reasons for the above, but it can be assumed that the reasons primarily rest with the fact that the dissolution of the USSR made the countries of this region enter a period of crisis and

isolation, with governance that is not in line with regulations and EU requirements. Such a situation continues to this day, with minor developments [9]. On the other hand, the official position of the European Union, which explained said policy, was that Central Asia is geographically distant and economically unimportant [10]. This has certainly become the subject of revision, so it is realistic to expect changes. The latest official document that defines the interests of the European Union in Central Asia was defined in 2019 in the form of the 2019 *New EU strategy on Central Asia*. It outlines the scope of cooperation in the period until 2027, primarily in the field of resilience, protection of human rights, support for regionalism and economic activities, with the EU's clear position that it has no geopolitical interest in this region and that it is interested in cooperation that would be in mutual interest [11].

During the Ukrainian crisis, the EU decided to stop the supply of natural gas from the Russian Federation and replace it with other sources of supply. Bearing in mind: that natural gas from the Russian Federation is an environmentally acceptable energy product, that the Russian Federation has been supplying the European Union with natural gas for several decades at favorable prices [12], that there are small available quantities of liquefied natural gas on the world market, while numerous infrastructure and investment problems stand in the way of the introduction of liquefied natural gas as an alternative [13], and taking also into account the lack of uranium in countries that are not involved in the conflict in Ukraine [14], it is not possible to assess with a satisfactory degree of certainty the further developments and possible perspective of the European Union when it comes to the supply of this energy product. Moreover, with the aim of reducing the impact on their own economies, certain countries of the European Union express different attitudes and implement different activities when it comes to coal, renewable energy sources, nuclear energy, as well as the continued supply of natural gas from the Russian Federation [15]. The European Union imports about 55% of all necessary energy products, whereby disagreements that exist within the European Union on this issue open up the possibility to create challenges in all spheres, including the ability of the European continent to reach the status of a carbon-free continent by 2050 [16].

The European Union and the EU candidate countries are in a situation where they have to find and enable a stable supply of natural gas from other sources, which is certainly a challenging task because in 2020 the European Union imported about 85% of natural gas from other countries, whereby the Russian Federation was the largest supplier [17]. Considering the geographical location and infrastructure limitations, there are conflicting opinions

on whether the EU can be supplied with natural gas and oil from the USA in the long term, and how this will affect its competitiveness [18]. In addition, geopolitical tensions make it much more difficult to establish supplies from Saudi Arabia and other Gulf countries. The unstable internal situation, turmoil and conflicts that often border on war, have been going on in Venezuela and Libya for decades, so it is completely impossible to supply the EU from these countries in the indefinite future. With this in mind, it is reasonable to expect the EU to intensify efforts to establish quality relations with a region that is rich in energy resources, stable and, at the same time, outside of direct conflict zones, but with which the EU has not developed cooperation on any basis so far. That region is Central Asia.

Central Asia is a region made up of five countries: the Kyrgyz Republic, Kazakhstan, Uzbekistan, Tajikistan and Turkmenistan. These countries underwent a complex historical development for which there are insufficient reliable data. However, it can be said that, due to a high degree of isolation and natural and climatic conditions, the countries of this region have progressed at a relatively slow rate compared to other countries in the immediate surroundings.

The Russian Empire expanded into the region of Central Asia starting in 1720, and a big change occurred in 1918 when these countries became part of the USSR. From that moment, these countries, which had no system of economy that would resemble the economies of other countries at the given historical moment, entered the process of rapid industrialization and reported the progress of the society in every sense. However, it should be taken into account that the consequences of the Soviet period are interpreted differently in academic literature [19], both in terms of the number of publications and the conclusions contained therein [20]. From that moment, the countries of Central Asia began to develop according to the principles of a centralized economy. A strong industrial, economic, and social progress of this region was recorded until the dissolution of the USSR in 1991 [21]. After the crisis that arose with the dissolution of the USSR, only around the year 2000 did the countries of Central Asia enter a faster transition from a centralized to a market economy, at different speeds and with different effects [22].

The countries of the Central Asian region have declaratively adopted the basic principles of sustainable development and incorporated them into their own strategies, but incompletely, with insufficient data on results. Numerous investments were launched, but research on data from 1971 to 2016 showed that their short-term impact on CO₂ emission was high and negative—completely independently of the economic

and political system. It is certain that the countries of Central Asia are still in a period when their economic development is more important than environmental protection [23]. Moreover, as a consequence of the transition period, government efficiency and insufficient transparency appear to be the main problems that stand in the way of a more successful and sustainable future, especially when it comes to the energy transition [24].

The USSR era saw a rapid development in the energy sector, primarily related to the production of electricity from newly built hydropower plants, as well as the exploitation of uranium as the basic fuel for nuclear power plants around the world. The countries of Central Asia are rich in energy resources that have not yet been sufficiently explored or used, and there are long-standing disputes over their use, especially when it comes to water resources and hydropower plants, which was not the case under Soviet regime [25]. Specifically, after the dissolution of the USSR, significant disputes arose between the countries of this region that share water resources and infrastructure for the production of electricity from hydropower, which continues to this day and has a detrimental effect on the development of these countries and the welfare of citizens [26].

The production of energy from renewable sources in the countries of this region is negligible, although since 2010, the first strategic initiatives have been recorded and the accompanying legal regulations have been adopted, with the aim of enhancing both the production of energy from renewable sources and investment in this area. The said process is additionally complicated by the fact that the electricity price is primarily a state-regulated social category and therefore subsidies have no effect. However, no significant progress in the field of climate change has been made, and the information regarding this matter are scarce and unreliable [27].

Due to their geostrategic position and wealth of natural resources that remained after the dissolution of the USSR in 1991, the countries of Central Asia became a region of interest for the foreign powers. Moreover, since the 2013 *Silk and belt* initiative of the People's Republic of China, the influence of China has been growing rapidly, primarily in the field of investment in the energy sector of this region [28], and there are clear views that Western countries (and therefore the EU) will have significant difficulties reaching China's position in this region [29]. Scholars argue that China is expected to exert influence on all the countries located on the Silk and Belt Road, in terms of the work of institutions, policy making and other important aspects that determine and can determine the export and energy policy of the countries of Central Asia, with a special emphasis on Kazakhstan [30].

With the outbreak of the Ukrainian crisis, the Central Asian region once again became the focus of US interest, primarily for security reasons and due to the Russian Federation's continued influence on the region [31]. The Central Asian region was not of strategic importance for the EU until the outbreak of the Ukrainian crisis, but the need to find new sources of energy changed this situation and led to the necessity to alter the European Union's approach to Central Asia [32].

The contemporary European Union recognizes the importance of Central Asia as a region rich in energy resources, but numerous changes are needed in the sphere of diplomatic approach. The largest project that aims to deliver natural gas from Central Asia (without passing through the territory of the Russian Federation) is the Southern Gas Corridor, but there are numerous geopolitical, technical and security challenges associated with the construction and operation of this route. Moreover, the European Union insists on doing business according to the principles of a liberal economy, which implies competition between countries that could supply it with gas in the future. The readiness of the countries of Central Asia for such an approach was unknown even before the Ukrainian crisis [33], and with the prolongation of the conflict, the level of uncertainty is growing. The best example of the problems that arise when planning such significant infrastructure projects in this region is the Trans-Caspian Gas Pipeline, about which negotiations between the Russian Federation, Turkmenistan, Kazakhstan and Azerbaijan have been underway for more than 20 years. This gas corridor could be of interest to the European Union, because it enables the direct connection of Turkmenistan (a country in Central Asia) and Azerbaijan with Europe, but since this conflicts with the interests of the USA, the future of this project is extremely uncertain [34].

From the perspective of acceptability of the Central Asian region as an exporter of energy products for the needs of the EU, it is also necessary to consider the basic projections for the future. According to estimates until 2050, the number of inhabitants in this region will increase by about 8%, GDP is expected to increase by about 35%, but the degree of urbanization will increase by up to 75%, which will result in major sustainability-related problems. The problems that may arise with the realization of GDP increase cannot be estimated at this moment, but they are certainly expected [35].

Lack of information and analysis in the academic literature makes it hard to provide an accurate and reliable insight into the specificities of the countries of this region. The latest detailed study of the economic, energy and environmental indicators in this region was conducted by the International Energy Agency in 2015. It

provides certain data, but also clearly indicates that the data are based on publicly available, but often unverified sources, that the data are often secondary in nature and cannot be verified, while some data are determined by using statistical prediction and determination of missing data, which may or may not be correct [36].

However, it is certain that these countries have traditionally been closed and that, after the collapse of the USSR, they have entered into a profound recession in which energy resources have continued to be exploited, but under conditions of weak states and a growing corruption [37]. On the other hand, the attempts of Western countries to strengthen cooperation with countries of this region are often unsuccessful, and the reasons for this failure are still to be determined, although it is reasonable to assume that they are rooted in diametrically different approaches and perceptions [38]. Even 30 years after the dissolution of the USSR, the countries of Central Asia have not reached the level of development they recorded before the dissolution of the USSR, and since they have been developing differently from other countries of the former USSR [39], it would be ungrateful to predict the region's future [40]. Moreover, the governments of the countries of this region show insufficient willingness to introduce substantial changes in the spheres of government according to Western standards and expectations [41] regarding corruption and measures that could lead to changes in this area, which is of particular importance for the countries that aspire to more intensive cooperation with the Central Asian region [42].

The research presented in this paper aims to contribute to the limited corpus of academic literature on the specificities of the development of this region. This will provide more information that can be significant both for planning the further development of these countries and for predicting the possibility of international cooperation, taking into account the fact that EU is primarily interested in a stable supply of energy from this region.

Methodology

The research methodology is defined in accordance with the main goal of the research: reviewing the basic indicators of economic, energy, social and institutional development while defining the key advantages and problems faced by the countries of this region, which represent and can represent factors of importance both for these countries themselves and for all the countries aspiring to more intensive cooperation with Central Asia in the future, including especially the European Union.

Bearing in mind the basic priorities and challenges faced by the EU after 2022, it is necessary to provide insight into the data of importance for EU policy and decision-making. The research aims to:

- Look at historical development indicators for each of the 5 countries of the region individually;
- Gain insight into statistical indicators of interest;
- Determine the values and indicators of sustainable development for Germany; and
- Compare the results obtained for Central Asian countries with Germany.

The research covers the period from 2011 to 2021. Table 1 shows the indicators used in the research.

The number and type of indicators to be used in any research are always a matter of particular interest. In the case of this research, the indicators that were used proved to be relatively reliable in previous research, although it must be pointed out that the very structure of the indicators and their values always remain questionable [43]. However, the aim of the research was not only to determine the value of individual indicators in certain countries, but also to look at the trend and correlation between them, as well as to make comparison with Germany.

Statistical analysis methods that include ANOVA were used in data processing and interpretation. The significance and level of acceptability of individual indicators was determined in addition to the analysis of time series, measures of marginal and central tendencies, and standard deviations. In order to observe the possible regularities of data change in individual indicators, the paper analyzed the correlation and covariance of indicators between each country.

Results

GDP per capita

Kazakhstan and Turkmenistan have greater GDP growth than Kyrgyzstan, Uzbekistan and Tajikistan. As of 2012, Kazakhstan and Turkmenistan have reported five-digit values for this indicator, the same as Germany, while the values have been significantly lower for the remaining countries, as shown in Table 2.

There is a very high correlation in GDP per capita between all 6 countries. The lowest correlation value of this indicator, which is still greater than 0.9 (90%), is

Table 1 Indicators, units and sources

Indicator	Unit	Source
GDP-PPP per capita	Current international \$	World Bank
Public debt	Central government debt, total, % of GDP	World Bank
Foreign debt	External debt, % of GDP	World Bank
Foreign-exchange reserves	Total reserves (includes gold, current US\$)	World Bank
Inflation	Consumer prices (annual %)	World Bank
Budget deficit	% of GDP	World Bank
Unemployment rate	Unemployment, total (% of total labor force)	World Bank
Poverty rate	Poverty gap at \$3.20 a day (2011 PPP) (%)	World Bank
Energy imports	Net (% of energy use)	World Bank
Health expenditure	% of GDP	World Bank
GINI	Index	World Bank
Governance effectiveness	Index	Worldwide Governance Indicators
The consumer price index	Index (2010 = 100)	World Bank
Corruption Perception Index	Index	Transparency International
Carbon emission	Metric tons per capita	World Bank
World Risk Index	Index	Bündnis Entwicklung Hilft

Table 2 GDP per capita in Central Asian countries and Germany (2011–2021)

Country	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Kyrgyz Republic	3297.36	3618.15	4042.89	4281.82	4214.83	4681.17	5046.69	5255.78	5480.29	4985.03	5725.38
Kazakhstan	20,779.44	22,032.17	24,504.77	24,726.47	23,224.12	23,818.82	24,862.97	26,154.60	27,463.97	26,750.45	27,798.94
Uzbekistan	5844.81	6061.95	6302.65	6494.86	6680.18	6796.90	6840.71	7252.14	7658.27	7746.43	7907.58
Tajikistan	2496.58	2750.36	3027.81	3303.10	3150.43	3114.90	3252.93	3496.89	3732.56	3854.19	3926.42
Turkmenistan	9811.70	11,295.00	12,057.20	13,491.00	13,690.60	13,862.30	14,205.00	15,200.00	16,194.20	16,804.55	17,503.08
Germany	42,541.53	43,359.61	44,993.89	47,011.55	47,609.78	50,579.68	53,071.46	55,235.37	55,652.89	54,844.55	58,461.27

between Germany and Kazakhstan, i.e., Germany and Tajikistan. Correlation values are given in Table 3.

To better display the connection of the indicators, two basic colors were used, throughout the analyses. The green color indicates that the indicators are positively correlated. The red color indicates that the indicators are negatively correlated. The intensity of the color indicates the degree of correlation: a darker shade indicates a stronger correlation, and a lighter shade indicates a weaker correlation. Comments in the text mainly refer to indicators with stronger correlations.

The coefficients of the regression line (Table 4) for individual countries show the similarity in the GDP per

capita change in Kazakhstan and Turkmenistan, as well as in the Kyrgyz Republic and Uzbekistan. The lowest GDP per capita growth is reported for Tajikistan, while Germany, on the other hand, has incomparably high annual GDP per capita growth when compared to all other observed countries.

Public debt

Public debt values are shown in Table 5.

As for Public debt, the correlation value is lower compared to GDP per capita, but it is still very significant. It is noticeable that Germany has a negative correlation with all the observed Central Asian countries that, on the

Table 3 GDP per capita correlations in Central Asian countries and Germany (2011–2021)

Country	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Kyrgyz Rep		0.95	0.98	0.98	0.98	0.98
Kazakhstan	1858595		0.99	0.97	0.94	0.91
Uzbekistan	585933	1666249		0.97	0.99	0.96
Tajikistan	380185	1129807	354752		0.98	0.92
Turkmenistan						
	2153722	6129519	1985721	1314898		0.95
Germany	5311905	14393990	4691187	3024574	17385435	

Covariance

Correlation

Table 4 GDP per capita regression analysis in Central Asian countries and Germany (2011–2021)

	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Intercept	− 463,067	− 1,267,390	− 422,243	− 262,477.7	− 1,538,453	− 3,666,870.2
Coefficient	232	641	213	132	770	1844

Table 5 Public debt in Central Asian countries and Germany (2011–2021)

Country	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Kyrgyz Republic	45.00	47.00	44.40	53.60	67.10	59.10	58.90	56.00	54.10	68.10	66.11
Kazakhstan	8.80	10.50	10.84	12.65	19.31	16.77	15.77	17.33	17.88	17.07	20.20
Uzbekistan	6.70	7.70	7.40	8.40	9.60	11.60	19.50	29.20	30.80	40.40	37.44
Tajikistan	35.90	32.40	29.20	27.50	34.30	42.00	50.40	47.90	43.10	47.77	50.77
Turkmenistan	10.05	18.07	19.99	16.81	22.10	25.10	30.60	31.40	32.80	30.90	36.85
Germany	86.10	88.60	84.10	83.90	79.80	77.00	72.40	69.10	67.50	78.70	67.83

other hand, have mutual correlations of 0.59 and higher. There are significant correlations between Turkmenistan and Kazakhstan, Uzbekistan and Tajikistan, Kazakhstan and the Kyrgyz Republic, as well as between Tajikistan and Uzbekistan. The correlation values are shown in Table 6.

The coefficients of the regression line for individual countries show that only Germany has reported a negative growth, and that public debt of Central Asian countries is growing. The similarity in the public debt change is reported for the Kyrgyz Republic and Tajikistan, but also for Turkmenistan, although to a slightly lesser degree. The lowest increase in the Public debt indicator is recorded for Kazakhstan, as shown in Table 7.

Foreign debt

Foreign debt values are shown in Table 8.

As for Foreign debt, the correlation value is not significant in most cases. The highest correlation is between Kazakhstan and Tajikistan (0.78), while the correlations between Kazakhstan and the Kyrgyz Republic, and Tajikistan and Uzbekistan, are at the limit of significance. Other correlations are less than 0.5, but there is also a large number of negative correlations indicating inversely proportional trends in the cases of those countries. The values of the correlation analysis are given in Table 9.

The coefficients of the regression line for individual countries show that negative increase in foreign debt was recorded for Germany and Turkmenistan, while it is increasing in the case of other Central Asian countries. When looking at the coefficients of the regression line, it is evident that similarities are almost non-existent, so the growth of foreign debt values is very different for the observed countries. This argument is in line with the

Table 6 Public debt correlations in Central Asian countries and Germany (2011–2021)

Country	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany	Correlation
Kyrgyz Rep		0.88	0.62	0.59	0.66	– 0.53	
Kazakhstan	12		0.68	0.66	0.84	– 0.81	
Uzbekistan	96	106		0.82	0.87	– 0.76	
Tajikistan	40	45	84		0.84	– 0.81	
Turkmenistan	41	52	85	54		– 0.90	
Germany	– 28	– 43	– 68	– 48	– 51		
Covariance							

Table 7 Public debt regression analysis in Central Asian countries and Germany (2011–2021)

	Kirgiz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Intercept	– 3896.27	– 2005.31	– 7425.56	– 4256.17	– 4766.76	4068.19
Coefficient	1.96	1.00	3.69	2.13	2.38	– 1.98

Table 8 Foreign debt in Central Asian countries and Germany (2011–2021)

Country	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Kyrgyz Republic	89.61	90.51	93.15	99.02	115.34	116.26	105.52	98.39	94.92	112.27	110.88
Kazakhstan	62.00	65.00	66.00	70.00	71.00	108.00	120.00	100.00	90.00	85.00	108.33
Uzbekistan	9.87	10.11	13.81	14.77	15.78	17.89	26.34	33.89	42.04	57.75	16.74
Tajikistan	32.50	28.50	25.70	22.70	27.90	32.70	40.30	38.90	36.00	37.50	39.64
Turkmenistan	15.80	12.60	14.70	19.00	20.00	18.90	15.40	8.00	14.10	13.78	13.46
Germany	163.08	165.86	150.74	153.55	151.18	152.22	146.20	144.92	144.72	165.10	147.76

Table 9 Public debt correlations in Central Asian countries and Germany (2011–2021)

Country	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Kyrgyz Rep		0.53	0.36	0.28	0.40	-0.19
Kazakhstan	206.0147		0.31	0.78	-0.19	-0.59
Uzbekistan	77.61873	71.70021		0.54	-0.33	-0.08
Tajikistan	9.283172	26.02753	47.26092		-0.54	-0.30
Turkmenistan	4.232876	-2.0633	-14.8699	-10.1823		0.08
Germany	-10.6701	-33.9963	-9.82111	-13.169	2.033201	

Covariance

Correlation

Table 10 Foreign debt regression analysis in Central Asian countries and Germany (2011–2021)

	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Intercept	-3336.27	-8943.30	-6544.66	-2668.5	663.0679	2350.651
Coefficient	1.71	4.48	3.26	1.34	-0.32143	-1.09

Table 11 Foreign-exchange reserves in Central Asian countries and Germany (2011–2021)

Country	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Kyrgyz Republic	0.18E+10	0.21E+10	0.22E+10	0.19E+10	0.18E+10	0.19E+10	0.22E+10	0.21E+10	0.24E+10	0.28E+10	0.25E+10
Kazakhstan	2.92E+10	2.83E+10	2.47E+10	2.93E+10	2.79E+10	2.96E+10	3.07E+10	3.1E+10	2.9E+10	3.56E+10	3.29E+10
Uzbekistan	2.25E+10	2.25E+10	2.25E+10	2.42E+10	2.43E+10	2.63E+10	2.81E+10	2.71E+10	2.93E+10	3.49E+10	3.27E+10
Tajikistan	0.05E+10	0.06E+10	0.06E+10	5.13E+10	0.04E+10	0.06E+10	0.13E+10	0.13E+10	0.15E+10	0.22E+10	0.18E+10
Turkmenistan	1.93E+10	2.02E+10	2.24E+10	2.26E+10	2.26E+10	1.09E+10	2.49E+10	2.02E+10	2.02E+10	2.01E+10	2.01E+10
Germany	23.4E+10	24.9E+10	19.9E+10	19.3E+10	17.4E+10	18.4E+10	20E+10	19.8E+10	22.4E+10	26.8E+10	21.8E+10

significantly lower correlation of this factor between all 6 observed countries. The results of the regression analysis are given in Table 10.

Foreign-exchange reserves

The values of this indicator are shown in Table 11.

As for the Foreign-exchange reserves indicator, the value of the correlations between Turkmenistan and Germany is not significant in most cases. On the other hand, Tajikistan has high correlations with Uzbekistan, Kazakhstan and the Kyrgyz Republic, and Uzbekistan has high correlations with Kazakhstan and the Kyrgyz Republic. No significant negative correlations have been reported

between the considered countries. Correlation analysis is shown in Table 12.

The coefficients of the regression line for Foreign-exchange reserves show that this indicator has a very negative growth for Turkmenistan, while the growth of Foreign-exchange reserves is exceptionally positive for Uzbekistan, Germany and Kazakhstan. For Tajikistan, but especially for the Kyrgyz Republic, the growth of this indicator is significantly lower—Table 13.

Inflation

The inflation values in the observed period are shown in Table 14.

Table 12 Foreign-exchange reserves correlations in Central Asian countries and Germany (2011–2021)

Country	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany	Correlation
Kyrgyz Rep		0.63	0.85	0.93	0.07	0.60	
Kazakhstan	4.54E+18		0.86	0.81	− 0.11	0.49	
Uzbekistan	1.37E+19	1.38676E+19		0.96	− 0.06	0.38	
Tajikistan	3.16E+17	2.76441E+17	2.24E+18		0.08	0.52	
Turkmenistan							
	8.15E+17	−1.26672E+18	− 7.5E+17	1.54E+17		0.01	
Germany	4.5E+20	3.71758E+20	4.23E+19	8.29E+18	7.72E+17		
Covariance							

Table 13 Foreign-exchange reserves regression analysis in Central Asian countries and Germany (2011–2021)

	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Intercept	− 1.4E+11	− 1.2E+12	− 2.36E+12	− 3.3E+11	1.18E+11	− 1.8E+12
X variable 1	7.1E+07	6.07E+08	1.186E+09	1.63E+08	− 4.9E+07	9.83E+08

Table 14 Inflation in Central Asian countries and Germany (2011–2021)

Country	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Kyrgyz Republic	16.64	2.77	6.61	7.53	6.50	0.39	3.18	1.54	1.13	6.33	0.30
Kazakhstan	8.42	5.10	5.85	6.71	6.67	14.55	7.44	6.02	5.25	6.75	7.17
Uzbekistan	4.60	4.10	4.15	6.40	5.50	5.60	9.50	17.60	14.51	12.98	15.99
Tajikistan	6.69	3.37	2.04	4.40	2.80	6.41	6.65	3.87	7.80	8.59	7.52
Turkmenistan	5.28	5.31	6.81	6.01	7.40	3.65	8.04	13.30	5.09	7.58	8.65
Germany	2.08	2.01	1.50	0.91	0.51	0.49	1.51	1.73	1.45	0.51	0.77

As for the Inflation indicator, the correlation values do not exceed the significance threshold of 0.5, except in the case of Uzbekistan and Turkmenistan, but there is a large number of negative correlations of lesser significance. When looking at the covariance, a high dynamic of inversely proportional changes in the value of this indicator is observed for Uzbekistan and the Kyrgyz Republic. Covariance also shows a significant but proportional change in the Inflation value for Uzbekistan with Turkmenistan and Uzbekistan with Tajikistan, as shown in Table 15.

The coefficients of the regression line for Inflation show that the Kyrgyz Republic reported a significant deflation in the observed period, while Germany and Kazakhstan reported a slight growth of this indicator due to negative influence. Uzbekistan had the highest inflation, while positive growth, recorded for Tajikistan and Turkmenistan, was below 0.5, as summarized in Table 16.

Budget deficit

The values of this indicator are shown in Table 17.

As for the Budget deficit indicator, the considered Central Asian countries reported no correlation with

Table 15 Inflation correlations in Central Asian countries and Germany (2011–2021)

Country	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany	Correlation
Kyrgyz Rep		− 0.07	− 0.50	− 0.08	− 0.22	0.28	
Kazakhstan	− 0.41192		− 0.25	0.27	− 0.40	− 0.41	
Uzbekistan	− 12.166	− 6.00268		0.49	0.66	− 0.11	
Tajikistan	− 0.37731	1.217724	5.171455		− 0.16	− 0.23	
Turkmenistan				− 0.8347446			
	− 1.28436	− 2.36479	7.93661	8		0.10	
Germany	0.094704	− 0.13677	− 0.31649	5	0.140365		
Covariance							

Table 16 Inflation regression analysis in Central Asian countries and Germany (2011–2021)

	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Intercept	1822.74	45.21	− 2739.18	− 820.7	− 652.2	186.1
Coefficient	− 0.90	− 0.02	1.36	0.41	0.33	− 0.09

Table 17 Budget deficit in Central Asian countries and Germany (2011–2021)

Country	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Kyrgyz Republic	− 4.70	− 5.90	− 3.70	− 3.10	− 2.50	− 5.80	− 3.70	− 0.60	− 0.10	− 3.30	− 1.22
Kazakhstan	5.80	4.40	4.90	2.50	− 6.30	− 4.50	− 4.30	2.60	− 0.60	− 7.00	− 6.26
Uzbekistan	5.10	5.90	2.20	1.90	− 0.20	0.80	1.20	2.00	0.60	− 2.50	− 1.89
Tajikistan	0.90	0.60	− 0.90	0.80	− 2.00	− 9.00	− 5.70	− 2.70	− 2.10	− 4.30	− 5.81
Turkmenistan	2.40	5.30	1.20	0.70	0.60	− 2.10	− 2.30	− 0.20	− 0.30	− 0.10	− 2.16
Germany	− 0.90	0.00	0.00	0.60	1.00	1.20	1.30	1.90	1.50	− 4.30	− 0.05

Germany. There is a very strong correlation of changes in this indicator for Uzbekistan and Kazakhstan, and further for Tajikistan and Turkmenistan (greater than 0.8). There are also significant correlations between Turkmenistan and Uzbekistan, i.e., Turkmenistan and Kazakhstan, as well as between Tajikistan and the same two countries. In conclusion, it can be pointed out that a significant correlation for the Budget deficit indicator exists in all Central Asian countries except in the Kyrgyz Republic, as shown in Table 18.

The coefficients of the regression line for the Budget deficit indicator show negative growth in all cases except

for the Kyrgyz Republic. Although this country reported a budget surplus in the observed period (table X), its value is permanently decreasing from year to year. The lowest negative increase in Budget deficit is reported for Germany. The summarized results are shown in Table 19.

Unemployment rate

The values of this indicator are shown in Table 20.

The correlations of the Unemployment rate indicator between the observed countries are significant and differ in their nature. Specifically, there are significant negative correlations between Germany and Uzbekistan, i.e.,

Table 18 Budget deficit correlations in Central Asian countries and Germany (2011–2021)

Country	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany	Correlation
Kyrgyz Rep		– 0.20	– 0.50	– 0.01	– 0.40	0.25	
Kazakhstan	– 4.61365		0.86	0.75	0.69	0.18	
Uzbekistan	– 2.92886	5.079461		0.63	0.75	0.26	
Tajikistan	– 0.09058	6.921795	4.599919		0.82	– 0.07	
Turkmenistan				5.28515			
	– 1.80946	3.113413	3.862584	2		– 0.20	
Germany	0.652983	0.47267	1.028373	– 0.3517	8	– 0.68836	

Covariance

Table 19 Budget deficit regression analysis in Central Asian countries and Germany (2011–2021)

	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Intercept	– 780.22	2202.14	1316.05	1233.73	982.62	101.62
Coefficient	0.39	– 1.09	– 0.65	– 0.61	– 0.49	– 0.05

Table 20 Unemployment rate in Central Asian countries and Germany (2011–2021)

Country	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Kyrgyz Republic	8.53	8.43	8.33	8.05	7.56	7.21	6.89	6.89	6.92	8.71	7.08
Kazakhstan	5.39	5.29	5.20	5.06	4.93	4.96	4.90	4.85	4.80	4.89	4.69
Uzbekistan	5.00	4.90	4.90	5.10	5.20	5.20	5.80	5.84	5.85	7.04	6.54
Tajikistan	10.24	9.58	8.91	8.23	7.55	6.90	6.95	7.01	7.06	7.58	6.15
Turkmenistan	4.09	4.09	4.11	4.14	4.14	4.17	4.20	4.23	4.27	4.95	4.57
Germany	5.820	5.380	5.230	4.980	4.620	4.120	3.750	3.380	3.140	3.810	2.85

Germany and Turkmenistan, as well as between Uzbekistan and Tajikistan, i.e., Uzbekistan and Kazakhstan. On the other hand, there are strong positive correlations between Tajikistan, Kazakhstan, Germany and the Kyrgyz Republic. Turkmenistan has a strong positive correlation with Uzbekistan—Table 21.

The negative coefficient of the regression line shows that the growth of the Unemployment rate indicator is negative in all countries except Turkmenistan. The biggest changes in this indicator are reported for Tajikistan

and Germany. They are more moderate for Uzbekistan and the Kyrgyz Republic, and negligible for Kazakhstan. Details of the analysis can be seen in Table 22.

Poverty rate

The values of this indicator for the research sample can be seen in Table 23.

Regarding the Poverty rate indicator, there are no significant correlations between the observed countries. The only correlation that is statistically significant is the one between Kazakhstan and Tajikistan: it

Table 21 Unemployment rate correlations in Central Asian countries and Germany (2011–2021)

Country	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany	Correlation
Kyrgyz Rep		0.73	− 0.20	0.80	0.12	0.54	
Kazakhstan	0.03		− 0.73	0.97	− 0.54	0.88	
Uzbekistan	− 0.09	− 0.33		− 0.63	0.93	− 0.84	
Tajikistan	1.16	1.41	− 0.51		− 0.43	0.85	
Turkmenistan	0.01	-0.03	0.16	− 0.13		− 0.69	
Germany	0.67	0.85	− 0.49	1.05	− 0.13		
Covariance							

Table 22 Unemployment rate regression analysis in Central Asian countries and Germany (2011–2021)

	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Intercept	252.66	128.77	− 382.89	685.81	− 116.19	581.10
Coefficient	− 0.12	− 0.06	0.19	− 0.34	0.06	− 0.29

Table 23 Poverty rate in Central Asian countries and Germany (2011–2021)

Country	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Kyrgyz Republic	2.9	3.5	4.2	2.4	3.5	2.4	2.5	1.8	1.6	2.9	1.9
Kazakhstan	0.10	0.1	0.1	0	0	0	0.1	0.1	0	0.10	0.05
Uzbekistan	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0.1
Tajikistan	4.4	4.4	4.5	4.5	4.5	4.5	4.4	4.4	4.4	4.4	4.4
Turkmenistan	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Germany	0	0	0	0	0	0	0.1	0	0	0	0.02

Table 24 Poverty rate correlations in Central Asian countries and Germany (2011–2021)

Country	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany	Correlation
Kyrgyz Rep		0.32	− 0.24	0.41	0.00	− 0.14	
Kazakhstan	7.1E-04		− 0.01	− 0.56	0.00	0.26	
Uzbekistan	− 5.6E-04	− 1.9E-05		− 0.02	0.00	− 0.32	
Tajikistan	9.1E-04	− 1.3E-03	− 3.7E-05		0.00	− 0.28	
Turkmenistan	− 2.0E-50	0.0E+00	1.8E-34	0.0E+00		0.00	
Germany	− 1.2E-04	2.2E-04	− 4.4E-04	− 3.9E-04	− 8.8E-36		
Covariance							

is a negative correlation (-0.56). It is interesting that the correlation of the poverty rate indicator for Turkmenistan with other observed countries is close to zero, as can be seen in Table 24.

For the Poverty rate indicator, the regression line is almost parallel to the X-axis (the coefficient of the regression line is close to zero). The exception is the Kyrgyz Republic where this indicator reported a negative growth in the observed period—Table 25.

Energy imports

Input data are shown in Table 26.

As for Energy imports, the general conclusion is that significant positive and negative correlations of changes exist in this indicator between the observed countries. The positive correlations are weaker, and only the correlations between Turkmenistan and Uzbekistan, i.e., Turkmenistan and Kazakhstan, are significant. Significant negative correlations exist between Germany and Kazakhstan (very large), Tajikistan and Turkmenistan, Uzbekistan and Kazakhstan. In addition, there is a notable value of covariance between Kazakhstan and Turkmenistan, implying a great similarity in the dynamics of change in the value of the Energy imports

Table 25 Poverty rate regression analysis in Central Asian countries and Germany (2011–2021)

	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Intercept	321.59	4.95	− 6.06	14.21	0.19	− 3.65
Coefficient	− 0.16	0.00	0.00	0.00	0.00	0.00

Table 26 Energy imports in Central Asian countries and Germany (2011–2021)

Country	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Kyrgyz Republic	51.05	57.70	55.47	49.54	48.44	53.33	51.22	52.78	54.89	55.09	53.39
Kazakhstan	− 104.13	− 107.235	− 122.883	− 107.342	− 116.89	− 111.65	− 118.78	− 115.46	− 114.56	− 116.66	− 118.76
Uzbekistan	− 18.55	− 21.04	− 17.50	− 26.16	− 24.65	− 22.39	− 23.49	− 22.91	− 24.48	− 25.11	− 25.96
Tajikistan	29.50342	28.73741	33.71686	36.2455	35.667	35.989	34.008	35.098	34.701	35.005	36.92627
Turkmenistan	− 164.212	− 166.233	− 191.918	− 191.511	− 205.365	− 216.123	− 226.882	− 237.64	− 248.399	− 259.157	− 269.915
Germany	60.56451	60.69546	62.09378	60.87591	61.40017	61.22218	61.22218	61.22218	61.22218	61.22218	61.3777

Table 27 Energy imports correlations in Central Asian countries and Germany (2011–2021)

Country	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Kyrgyz Rep		− 0.11	0.32	− 0.37	− 0.09	0.13
Kazakhstan	− 3.46		0.10	− 0.53	0.60	− 0.91
Uzbekistan	2.40	0.73		− 0.68	0.65	0.10
Tajikistan	− 2.37	− 3.39	− 4.76		− 0.71	0.51
Turkmenistan	− 105.56	697.37	60.69	− 61.51		− 0.37
Germany	0.02	− 0.14	0.11	0.50	− 4.94	

Covariance

Correlation

indicator in these two countries. The details of the analysis are shown in Table 27.

The coefficient of the regression line shows a distinct trend of negative increase in the Energy imports indicator for Turkmenistan. The values of this parameter in other observed countries range in value around zero, implying a slight increase in this indicator in all other countries (the regression line is almost parallel to the X-axis). The complete results of the regression analysis for this indicator are shown in Table 28.

Health expenditure

Indicators by country are shown in Table 29.

There is a very different degree of correlation of the Health expenditure indicator between the observed countries. It is interesting that the Kyrgyz Republic has negative correlations with all the others (except Kazakhstan), whereby the correlations with Germany, Tajikistan and Turkmenistan are very significant. In addition, there is a significant negative correlation between Kazakhstan and Uzbekistan. On the other hand, there are strong positive correlations of the Health expenditure indicator between Germany, Tajikistan and Turkmenistan. Moreover, there is a significant value of covariance between Tajikistan and Turkmenistan, implying a great similarity in the dynamics of change in the value of the Energy

Table 28 Energy imports regression analysis in Central Asian countries and Germany (2011–2021)

	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Intercept	− 108.16	1791.76	1198.04	− 1087.17	21,472.94	− 13.45
Coefficient	0.08	− 0.95	− 0.61	0.56	− 10.76	0.04

Table 29 Health expenditure in Central Asian countries and Germany (2011–2021)

Country	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Kyrgyz Republic	7.11	8.51	8.19	7.36	7.15	6.41	6.19	5.01	4.49	4.46	4.09
Kazakhstan	2.60	3.04	2.66	2.97	3.04	3.42	3.05	2.82	2.79	2.71	2.93
Uzbekistan	5.14	5.46	5.66	4.67	4.99	4.97	5.08	5.30	5.62	5.51	5.37
Tajikistan	5.86	5.98	6.53	6.67	6.91	7.00	7.23	7.24	7.11	7.11	7.58
Turkmenistan	4.90	4.78	5.15	5.50	6.30	6.62	6.94	6.61	6.57	7.33	7.62
Germany	10.78	10.85	11.00	11.02	11.18	11.24	11.33	11.45	11.70	11.70	11.81

Table 30 Health expenditure correlations in Central Asian countries and Germany (2011–2021)

Country	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Kyrgyz Rep		0.12	− 0.24	− 0.79	− 0.87	− 0.94
Kazakhstan	0.0061		− 0.53	0.24	0.21	− 0.02
Uzbekistan	− 0.0210	− 0.0464		0.03	0.05	0.33
Tajikistan	− 0.2040	0.0624	0.0038		0.94	0.89
Turkmenistan	− 0.7629	0.1875	0.0146	0.4465		0.92
Germany	− 0.1064	− 0.0020	0.0327	0.1519	0.2898	

Covariance

Correlation

imports indicator in these two countries, as shown in Table 30.

Regression analysis indicates a negative increase in the Health expenditure indicator for the Kyrgyz Republic, almost no increase for Uzbekistan, and especially for Kazakhstan, and slightly positive increase for other countries—Table 31.

GINI

GINI index values are given in Table 32.

As for the GINI indicator, there are only three significant values in the correlation matrix. The highest correlation is between Turkmenistan and Tajikistan, while Germany has significant correlations with the Kyrgyz Republic and Tajikistan. Looking at the values of the covariance, a significant similarity in the dynamics of change in this indicator was observed for Germany and the Kyrgyz Republic, as shown in Table 33.

Table 31 Energy imports regression analysis in Central Asian countries and Germany (2011–2021)

	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Intercept	886.83	− 4.54	− 41.35	− 291.25	− 560.82	− 201.53
Coefficient	− 0.44	0.00	0.02	0.15	0.28	0.11

Table 32 GINI in Central Asian countries and Germany (2011–2021)

Country	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Kyrgyz Republic	27.8	27.4	28.8	26.8	29	26.8	27.3	27.7	29.7	29	28.72
Kazakhstan	28	28.2	27.1	27	26.8	27.2	27.5	27.8	27.70	27.60	27.43
Uzbekistan	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
Tajikistan	0.53	0.54	0.54	0.53	0.53	0.54	0.55	0.55	0.55	0.55	0.55
Turkmenistan	0.61	0.61	0.61	0.61	0.6	0.61	0.62	0.62	0.62	0.62	0.62
Germany	30.8	31.1	31.5	30.9	31.6	31.6	31.2	31.7	31.7	31.7	31.85

Table 33 GINI correlations in Central Asian countries and Germany (2011–2021)

Country	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Kyrgyz Rep		− 0.06	0.00	0.32	0.17	0.59
Kazakhstan	− 0.01042		0.00	0.32	0.43	− 0.22
Uzbekistan	− 3.4E-47	6.76E-47		0.00	0.00	0.00
Tajikistan	2.37E-05	2.38E-05	− 1.3E-32		0.90	0.66
Turkmenistan	7.15E-06	1.86E-05	1.12E-33	5.12E-05		0.37
Germany	0.069571	− 0.02624	− 5.7E-31	0.00195	0.000835	

Covariance

Correlation

Regression analysis indicates small increase in the GINI indicator for most of the observed countries. The exceptions are Germany and the Kyrgyz Republic, with a slightly positive increase. When looking at the measured values of this indicator for these two countries, it is evident that they are many times higher than for other countries. The exception is Kazakhstan, whose GINI indicator values are similar to those of Germany and the Kyrgyz Republic. In all other cases, the regression line of this indicator is almost parallel to the X-axis. The results of the regression analysis are shown in Table 34.

Government effectiveness

The values of this indicator for the sample countries are shown in Table 35.

Only a few values in the correlation matrix for the Government effectiveness indicator are significant. The strongly positive correlation between Kazakhstan and Uzbekistan, and the significantly negative correlation between the Kyrgyz Republic and Turkmenistan, i.e., the Kyrgyz Republic and Germany, stand out. In addition, the value of covariance between Kazakhstan and Uzbekistan indicates a great similarity in the dynamics of change in the Government effectiveness indicator in these two countries, as shown in Table 36.

Table 34 GINI regression analysis in Central Asian countries and Germany (2011–2021)

	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Intercept	− 224.82364	48.25576	0.59618	− 3.97861	− 2.44079	− 142.07515
Coefficient	0.12545	− 0.01030	− 0.00001	0.00224	0.00152	0.08606

Table 35 Government effectiveness in Central Asian countries and Germany (2011–2021)

Country	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Kyrgyz Republic	29.86	29.86	30.81	17.79	18.27	17.79	23.08	29.33	25.00	32.69	25.43
Kazakhstan	42.18	40.28	35.55	53.37	50.48	50.48	52.40	54.33	57.69	60.10	62.16
Uzbekistan	29.38	18.48	18.96	27.20	26.92	31.73	32.21	33.65	34.13	34.13	36.87
Tajikistan	17.06	18.01	14.69	22.12	19.71	13.94	12.98	12.50	14.42	24.52	16.92
Turkmenistan	3.32	9.48	9.00	18.75	19.23	11.54	10.10	10.10	11.06	12.02	13.50
Germany	91.00	91.94	90.52	93.75	92.79	93.75	93.75	92.31	92.79	88.94	92.06

Table 36 Government effectiveness correlations in Central Asian countries and Germany (2011–2021)

Country	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Kyrgyz Rep		− 0.23	− 0.13	0.02	− 0.68	− 0.84
Kazakhstan	− 14.67		0.88	0.21	0.44	0.13
Uzbekistan	− 4.54	29.70		− 0.08	0.07	0.11
Tajikistan	0.30	2.78	− 1.79		0.45	− 0.42
Turkmenistan	− 12.19	7.88	1.70	7.09		0.39
Germany	− 1.74	0.28	0.94	− 2.22	2.36	

Covariance

Correlation

The regression analysis shows a significant positive increase in the Government effectiveness indicator in the case of Kazakhstan, and somewhat lower increase in the case of Uzbekistan. The increase in the value of this indicator is almost negligible in the case of the Kyrgyz Republic, Tajikistan and Germany, and slightly positive in the case of Turkmenistan, as detailed in Table 37.

The consumer price index

The values of this indicator for the given period are shown in Table 38.

As for the Consumer price index indicator, correlations are positive, while the negative ones are statistically negligible. There are very strong correlations between Uzbekistan, the Kyrgyz Republic and Kazakhstan, as well as between Tajikistan and Germany. Tajikistan and Germany have moderate correlations with Uzbekistan, the Kyrgyz Republic and Kazakhstan. High values of covariance between Uzbekistan, the Kyrgyz Republic and Kazakhstan indicate a great similarity in the dynamics of change in the Consumer price index indicator in these three countries. Detailed values are shown in Table 39.

Table 37 Government effectiveness regression analysis in Central Asian countries and Germany (2011–2021)

	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Intercept	32.29	– 4520.49	– 2971.24	43.01	– 736.35	124.71
Coefficient	0.00	2.27	1.49	– 0.01	0.37	– 0.02

Table 38 The consumer price index in Central Asian countries and Germany (2011–2021)

Country	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Kyrgyz Republic	963.21	1019.03	1070.34	1135.38	1201.02	1272.04	1365.03	1417.48	1527.91	1659.01	963.22
Kazakhstan	246.26	258.86	273.95	292.35	311.80	357.18	383.72	406.84	428.17	457.28	246.27
Uzbekistan	111.24	112.45	125.83	140.55	153.31	166.29	180.96	206.07	242.18	277.36	111.24
Tajikistan	112.43	118.99	124.95	132.58	140.15	148.57	152.06	155.44	158.99	160.04	171.35
Turkmenistan	112.00	108.50	109.00	105.50	105.50	105.50	108.00	108.00	108.00	108.00	106.57
Germany	102.08	104.13	105.69	106.65	107.20	107.73	109.35	111.25	112.85	113.43	114.69

Table 39 The consumer price index correlations in Central Asian countries and Germany (2011–2021)

Country	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Kyrgyz Rep		0.99	0.99	0.57	– 0.16	0.60
Kazakhstan	5347.727		0.97	0.60	– 0.15	0.60
Uzbekistan	2814.679	2773.537		0.58	– 0.10	0.63
Tajikistan	186.525	193.62	562.2792		– 0.48	0.97
Turkmenistan				– 15.718		
	– 0.54145	– 0.51036	– 10.219	9		– 0.38
				67.4013		
Germany	8.855382	8.921796	129.6561	6	– 2.66159	

Covariance

Correlation

Regression analysis indicates positive increase for Uzbekistan, the Kyrgyz Republic and Kazakhstan. A particularly high positive increase stands out for the Kyrgyz Republic (the coefficient is 42.37). In addition, Tajikistan has a positive increase, while Turkmenistan and Germany record insignificant increase compared to other countries—Table 40.

Corruption perception index

Input data for this indicator are presented in Table 41.

The corruption perception index indicator shows significant correlations. All values in the correlation matrix are positive, and the most pronounced are those

between Uzbekistan, the Kyrgyz Republic and Kazakhstan, as well as between Germany on the one hand, and the Kyrgyz Republic and Turkmenistan on the other hand. Turkmenistan has slightly smaller but significant positive correlations with the remaining countries of Central Asia. Covariance shows a great similarity in the dynamics of change in the Corruption Perception Index indicator between Uzbekistan, the Kyrgyz Republic and Kazakhstan—Table 42.

Regression analysis indicates that all observed countries report positive increase in the Corruption Perception Index indicator. The increase in this indicator is slightly higher in the case of Uzbekistan, the Kyrgyz

Table 40 The consumer price index regression analysis in Central Asian countries and Germany (2011–2021)

	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Intercept	− 84,185.61	− 28,207.91	− 21,228.76	− 11,193.02	559.76	− 2331.04
Coefficient	42.37	14.16	10.61	5.62	− 0.22	1.21

Table 41 Corruption Perception Index in Central Asian countries and Germany (2011–2021)

Country	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Kyrgyz Republic	23	24	24	27	28	28	29	29	30	31	32.1
Kazakhstan	27	28	26	29	28	29	31	31	34	38	39.0
Uzbekistan	16	17	17	18	19	21	22	23	25	26	26.7
Tajikistan	21	22	22	23	26	25	21	25	25	25	25.7
Turkmenistan	16	17	17	17	18	22	19	20	19	19	20.6
Germany	77	79	78	79	81	81	81	80	80	80	81.3

Table 42 Corruption Perception Index correlations in Central Asian countries and Germany (2011–2021)

Country	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Kyrgyz Rep		0.88	0.95	0.72	0.73	0.82
Kazakhstan	15.04		0.94	0.54	0.53	0.53
Uzbekistan	12.86	12.66		0.64	0.72	0.68
Tajikistan	2.39	1.81	4.32		0.64	0.66
Turkmenistan	2.17	1.57	4.55	2.03		0.80
Germany	1.40	0.92	3.29	1.57	1.81	

Covariance

Correlation

Republic and Kazakhstan, and it is significantly lower in the case of Turkmenistan, Tajikistan and Germany, as shown in Table 43.

Carbon emission

The values of this indicator are shown in Table 44.

The correlation matrix for the Carbon emission indicator shows great differences between individual countries. Apart from strong positive correlations between Kazakhstan and Uzbekistan, i.e., Kazakhstan and Germany, another positive correlation is reported between Turkmenistan and Germany. Tajikistan has a strong negative correlation with Germany and Kazakhstan, and a slightly

weaker negative correlation with Uzbekistan and Turkmenistan, as detailed in Table 45.

Regression analysis shows small incremental changes in the Carbon emission indicator. A more significant negative increase is reported for Kazakhstan, and almost negligible for Uzbekistan and Turkmenistan. It is absent in the case of the Kyrgyz Republic, and slightly positive only for Tajikistan. The details of the analysis are shown in Table 46.

World Risk Index

The values of this aggregate index are shown in Table 47.

Table 43 Corruption Perception Index regression analysis in Central Asian countries and Germany (2011–2021)

	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Intercept	– 1743.90	– 2369.96	– 2300.48	– 770.48	– 787.80	– 531.16
Coefficient	0.88	1.19	1.15	0.39	0.40	0.30

Table 44 Carbon emission in Central Asian countries and Germany (2011–2021)

Country	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Kyrgyz Republic	1.38	1.79	1.64	1.66	1.72	1.60	1.52	1.78	1.56	1.56	1.62
Kazakhstan	14.82	14.57	15.26	12.10	10.87	11.36	11.90	11.85	11.46	11.46	10.26
Uzbekistan	4.38	3.80	3.70	3.41	3.17	3.30	3.38	3.41	3.48	3.48	3.16
Tajikistan	0.33	0.38	0.40	0.55	0.58	0.70	0.83	0.95	1.01	1.01	1.15
Turkmenistan	12.42	12.65	13.10	13.09	13.06	13.19	12.95	12.70	12.49	12.26	12.13
Germany	9.30	9.45	9.62	9.09	9.09	9.07	8.86	8.54	7.91	7.91	7.90

Table 45 Carbon emission correlations in Central Asian countries and Germany (2011–2021)

Country	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Kyrgyz Rep		– 0.10	– 0.45	– 0.01	0.28	0.14
Kazakhstan	– 0.277		0.84	– 0.80	0.14	0.73
Uzbekistan	– 0.050	0.092		– 0.64	– 0.20	0.45
Tajikistan	– 0.001	– 0.061	– 0.058		– 0.50	– 0.94
Turkmenistan	0.034	0.018	– 0.023	– 0.048		0.68
Germany	0.053	0.267	0.090	– 0.157	0.147	

Covariance

Correlation

Table 46 Carbon emission regression analysis in Central Asian countries and Germany (2011–2021)

	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Intercept	0.99	858.60	148.01	− 173.07	117.53	368.13
Coefficient	0.00	− 0.42	− 0.07	0.09	− 0.05	− 0.18
Sample size	55					
Confidence	1.407031					
	0.092187					

Table 47 World Risk Index in Central Asian countries and Germany (2011–2021)

Country	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Kyrgyz Republic	7.96	7.94	7.86	7.69	7.56	7.47	7.49	7.42	7.43	7.33	7.21
Kazakhstan	3.94	3.90	3.96	4.08	3.90	3.86	3.89	3.82	3.64	3.59	3.65
Uzbekistan	8.18	8.14	8.12	8.10	8.09	8.01	7.95	7.74	8.05	7.95	7.86
Tajikistan	6.31	6.24	6.16	6.13	6.09	6.17	6.29	6.36	5.85	5.85	5.97
Turkmenistan	6.56	6.45	6.51	6.43	6.47	6.22	6.19	6.08	5.90	5.93	5.85
Germany	2.74	2.70	2.68	2.64	2.61	2.54	2.51	2.50	2.66	2.64	2.54

Table 48 World Risk Index correlations in Central Asian countries and Germany (2011–2021)

Country	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Kyrgyz Rep		0.73	0.79	0.53	0.89	0.74
Kazakhstan	0.0153		0.51	0.70	0.89	0.21
Uzbekistan	0.0126	0.0081		0.01	0.73	0.84
Tajikistan	0.0149	0.0197	0.0003		0.60	− 0.13
Turkmenistan	0.0567	0.0563	0.0233	0.0254		0.52
Germany	0.0044	0.0013	0.0082	− 0.0018	0.0101	

Covariance

Correlation

Table 49 World Risk Index regression analysis in Central Asian countries and Germany (2011–2021)

	Kyrgyz Republic	Kazakhstan	Uzbekistan	Tajikistan	Turkmenistan	Germany
Intercept	155.78	80.57	70.70	71.01	160.80	33.65
Coefficient	− 0.07	− 0.04	− 0.03	− 0.03	− 0.08	− 0.02

The correlation matrix for the World Risk Index indicator shows significant positive correlations between most of the observed countries. The only correlations that are statistically insignificant (<0.5) are those between

Uzbekistan and Tajikistan, Kazakhstan and Germany, and Tajikistan and Germany. The covariance between Turkmenistan and the Kyrgyz Republic, i.e., Turkmenistan

and Kazakhstan, is somewhat more significant compared to other covariance values, as shown in Table 48.

Regression analysis shows a slight negative increase in the World Risk Index indicator in all countries (regression line coefficient is less than -0.1). Details are shown in Table 49.

Discussion

The main results of the data processing show no significant correlation between the six indicators: Unemployment rate, Poverty rate, Carbon emission, Health expenditure, Consumer Price Index and GINI. The analysis of these indicators resulted in very small positive or negative correlations, but without statistical significance. The regression analysis showed that the values of these indicators had a slight increasing or decreasing trend, without greater significance and influence on other indicators. On the other hand, these indicators are of great importance for the sustainable development of any country, especially the countries with lower GDP per capita values. Therefore, it is evident that no significant progress has been achieved in this sphere of social sustainability.

The related economic indicators show a higher degree of correlation. GDP per capita is growing in all countries in the sample, and the largest increase within Central Asia is recorded in Kazakhstan. The Public debt indicator is gradually decreasing only in Germany, and all Central Asian countries are showing an increasing trend, whereby the lowest increase in the Public debt indicator is reported for Kazakhstan. Foreign debt is an indicator for which no significant correlations were

found, whereby it is decreasing in Germany and Turkmenistan, and steadily increasing in other countries in the sample. The Foreign exchange reserves indicator has an extremely negative trend when it comes to Turkmenistan, but this trend is positive in other countries. When it comes to the Inflation indicator, correlations between countries are high (which may speak in favor of imported inflation), with the highest inflation recorded for Uzbekistan, and deflation for the Kyrgyz Republic. All Central Asian countries record a high correlation when it comes to the Budget deficit indicator, with a negative trend. The best indicator values are recorded in Germany, where the amount of the Budget deficit is at a stable level, without major fluctuations.

When analyzing the Energy imports indicator, high correlations and different trends are observed. There is a very high positive correlation between Turkmenistan and Kazakhstan, which may suggest that all the mentioned countries have a similar energy policy, and are well connected in infrastructure terms. Regression analysis showed that Germany recorded the same values of the Energy imports indicator in the mentioned period. Turkmenistan is an absolute energy exporter.

The Government efficiency and Corruption Perception Index indicators have similar values in analysis. The correlation is highly positive for Kazakhstan and Uzbekistan, with positive trend data only for Kazakhstan. Correlations for the Corruption Perception Index are very high for all Central Asian countries, and regression analysis shows a slight increasing trend in all countries, with Kazakhstan and Uzbekistan leading the way.

Table 50 Central Asia data processing—confidence interval (2011–2021)

	Min	Max	Stdev.p	Mean	Confidence	Conf/uod
Inflation	0.302574	17.6	4	6.745812	1	0.058
Corruption perception index	16	39	5.376446	24.38424	1.420895	0.062
Budget deficit	− 9	5.9	3	− 1.008	0.92099	0.062
Government effectiveness	3.32	62.15733	14.62069	26.86467	4	0.066
Unemployment rate	4.086	10.241	2	6.073724	0.4241	0.069
Health expenditure	2.602367	8.509664	2	5.495839	0.427883	0.072
The consumer price index	105.5	1659.01	439.9091	397.1625	116.2598	0.075
Public debt	6.7	68.1	17	31.11244	5	0.075
Energy Import	− 269.915	57.69747	101	− 53.1897	27	0.082
GDP	2496.582	27,798.94	8069	10,700.97	2132	0.084
World Risk Index	3.59	8.18	1.472548	6.359826	0.389167	0.085
Foreign debt	8	120	37	52.63822	10	0.089
Foreign exchange reserves	4.93E + 08	3.56E + 10	1.25E + 10	1.6E + 10	3.29E + 09	0.094
Carbon emission	0.332575	15.26279	5.323987	6.1882	1.407031	0.094
Poverty rate	0	4.5	2	1.487758	0.480218	0.107
GINI	0.53	29.7	13	11.46069	4	0.121

Indicators for Germany show stability and moderate growth, where good and highly positive indicators are reported when it comes to the Government Effectiveness and Corruption Perception Index. In addition to the regression analysis data of the indicators presented in the previous chapter, the following table (Table 50) shows other statistical parameters of the observed sample, by indicators. Apart from the standard deviation, a confidence interval (with $\alpha=0.05$) which brings the mean and standard deviation into relation was calculated with the aim of obtaining values easier to use in exploratory analysis and sorting. Confidence interval estimates the level of uncertainty that the observed indicator introduces into the model. For the purpose of comparison and ranking of the results obtained for different indicators, the confidence interval was normalized by using the quotient of confidence interval to the max–min difference (*conf/uod*). This ratio also depicts the frequency

distribution, i.e., the dispersion of the results on the x-axis of the Gaussian curve.

On the basis of the obtained results, a significant difference is observed in terms of the *conf/uod* quotient in indicators. It ranges from 0.058 to 0.121. The presented indicators are ranked by this instant parameter. For example, the *conf/uod* quotient is twice as low in the Inflation and Corruption Perception Index indicators (ranked the best) compared to the GINI and Poverty Rate indicators (ranked the worst). Figure 1 presents frequency distribution histograms for these four indicators, as contrasting examples that reflect the challenges of data processing today and in the future.

Regardless of the fact that the values of four indicators recorded over the 10 previous years for 5 Central Asian countries are included, the difference in their distribution, and thus the dynamics of their changes, is

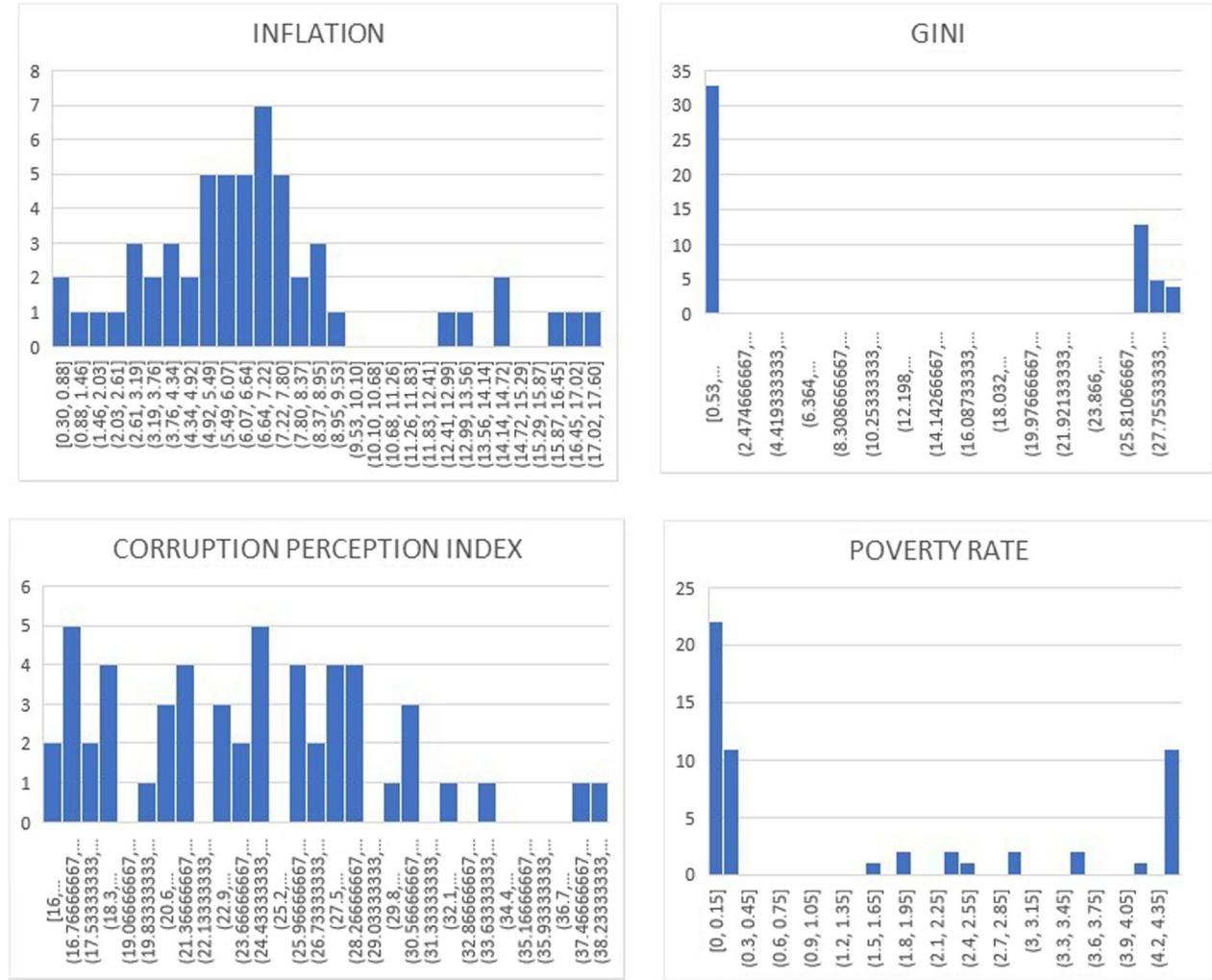


Fig. 1 Frequency distribution for Inflation, GINI, Corruption perception index and Inflation in Central. Asia (2011–2021)

obvious. Inflation and the Corruption Perception Index are particularly volatile and therefore unpredictable.

On the basis of the research results it can be concluded that further monitoring should be carried out on a revised set of indicators that will include only the indicators with the highest degree of certainty which contribute to changes in the final result: GDP, Inflation, Foreign exchange reserves, Energy import, and Carbon emission. Socially related indicators show a lower degree of unreliability, and their values between countries are similar. Therefore, their further monitoring within the research of this type can be considered superfluous in a methodological sense.

Conclusions

The economic progress of the European Union was possible largely due to the stable supply of energy, mostly from imports. After adopting appropriate environmental policies, natural gas from the Russian Federation, as an environmentally friendly energy source, has become a reliable support for the further development of the European Union for almost three decades, and its favorable prices have enhanced the competitiveness of the European economy. With the transition to the twenty-first century, trade between the European Union and the Russian Federation regarding the supply of natural gas and oil continued and grew in volume and value, with no problems reported even during the COVID-19 pandemic. The increasing needs of the EU economy were recognized and met by the construction of Nord Stream 1, but Nord Stream 2 would be a chance to enable the fulfillment of all European needs for this energy product. Nord Stream 2 was built, and the infrastructure brought up to Germany, but the commencement of exploitation was halted for geopolitical reasons.

With the outbreak of the Ukrainian crisis, the European Union made a decision to gradually stop importing energy products from the Russian Federation, and has been forced to find other sources of supply. Bearing in mind that the largest reserves of natural gas and uranium are located in only a few countries in the world, it is necessary to take complex steps and initiatives in order to enable supply from new, often remote regions.

Central Asia represents a region rich in energy resources, of which natural gas and uranium are certainly the most important for the European Union. Therefore, the efforts to establish a stable supply from the countries of this region are clear. On the other hand, five countries of Central Asia are heavily influenced by the Russian Federation and China, and apart from that, the state of their economy and government efficiency are unknown. The main goal of this paper is therefore based on the analysis of available indicators that can indicate the internal

specificities and challenges the European Union may face in its efforts to establish cooperation with these countries. The United States of America has had certain geopolitical interests in this region for decades. These were initially based solely on the fight against terrorism (and not on economic and trade cooperation), with fortified efforts in the second decade of the twentieth century to expand cooperation to energy trade, economy and sovereignty strengthening, and subsequently on attempts to weaken the influence of the Russian Federation and China in the region [44].

Data were analyzed for 16 indicators, in the period from 2011 to 2021, and Germany was included in the sample in order for the comparison to be enabled. The results showed that the countries of Central Asia are directly or indirectly connected and lead a similar economic and energy policy, with the low values of the Government efficiency and Corruption Perception Index standing out as indicators of special importance for international business cooperation. The above greatly hinders a faster progress of these countries after the dissolution of the USSR and represents a kind of challenge on the world geopolitical scene and in the domain of economic cooperation. However, there are no clear indications from the governments of said countries about the measures planned in order to improve the above indicators, so that the countries of Central Asia, which are rich in all energy resources, could become a more reliable trade partner on the global level, and primarily to the European Union. The measures needed to reduce the level of corruption are diverse, and they relate primarily to the prevention of corruption, reporting and legal processing of corrupt activities, and the elimination of the consequences of corruption. This long and complex process requires changes in legislation and cultural norms, as well as the public's recognition of corrupt activities as a negative and harmful phenomenon.

If the European Union wants to intensify the import of energy products from Central Asia, it should make plans for the abovementioned from the aspects that are present in this region, and should consider whether it can respect the legal framework, governance and other norms that exist in the Central Asian region. Considering the basic indicators of this research, it is not realistic to expect that Central Asian countries will introduce changes in their own governance solely based on the demands of the European Union (or any other country). This would require a change in certain principles when it comes to the European Union's foreign policy, which would be a big step, but the urgency of the issue of its energy security may lead to the aforementioned, if not to the full extent, then in details. It is difficult to predict

what the future will bring in this regard. Therefore, this issue requires more intensive observation, along with monitoring and qualitative and quantitative analysis.

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Author contributions

BV and IP prepared concept of the study and literature review and conducted data collection. GŠ conceptualized and conducted data processing. All authors participated in discussion and interpretation of data processing results. All authors participated in manuscript editing and approved the final manuscript.

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