A Structural Analysis of Eurasian Economic Union States' Gross Domestic Product: A Conservation of a Middle-Income Trap

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Abstract

The research employs a comprehensive analysis of existing literature, statistical data, and expert opinions to identify the primary challenges and opportunities for economic development within the EAEU. It develops a new conceptual framework for understanding the dynamics of economic integration and development in the EAEU. The study proposes a set of policy recommendations designed to promote innovation, enhance competitiveness, and foster sustainable economic development within the EAEU. The findings can be applied by policymakers, business leaders, and other stakeholders in the EAEU region, providing them with new insights into the challenges and opportunities of economic integration and development.

Keywords Economic Complexity · Economic Growth · Gross Domestic Product · Middle-income trap · Regional Integration · Theory of Percolation

Introduction

This study focuses on the Eurasian Economic Union (EAEU) as a platform for substantial transformational processes, where a retrospective analysis will aid in understanding the nature of this market and serve as a basis for forecasting its dynamics.

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This work is part of a research project aimed at analyzing Gross Regional Product (GRP) in the context of integration processes within the EAEU.

The EAEU possesses significant potential for economic growth due to its geographical position between Europe and Asia. Analysis of the GDP of EAEU member states demonstrates that these countries experience varying rates of economic growth, which may be attributed to differing levels of economic complexity and integration into the global economy. Our findings also reveal a high level of dependency on the export of raw materials among EAEU countries, which may impede their economic development. An additional aspect of our hypothesis is that the EAEU could become a hub for economic flows from the People's Republic of China and BRICS, potentially leading to economic growth for EAEU member states. However, achieving this requires the development of infrastructure, improvement of the business climate, and diversification of the economies of EAEU countries.

The objective of this study is to examine the Eurasian Economic Union (EAEU) as a magnet for economic flows from the People's Republic of China and BRICS, with EAEU member states playing a pivotal role in shaping the regional economic architecture. A retrospective analysis of GDP per capita in EAEU countries, as well as an examination of their export and import structures, has been conducted.

Overall, the study demonstrates that the EAEU holds substantial potential for economic growth, provided that its member states leverage the opportunities presented by the People's Republic of China and BRICS. The retrospective analysis of GDP per capita and the analysis of export and import structures within the EAEU will aid in understanding the nature of this market and serve as a foundation for forecasting its dynamics.

The rest of the paper is organized as follows. Section 2 provides an overview of the literature relevant to our research goals. Section 3 describes the data used and our methods including an RStudio code. Section 4 contains the results of our research. The conclusions of the authors, unresolved issues, and directions for further research are included in the concluding sections.

Literature Review

The Eurasian Economic Union (EAEU) is a subject of interest for scholars and researchers in the fields of economics, international relations, and area studies. Established in 2015, the EAEU is a regional economic organization aimed at promoting economic integration and cooperation among its member states, which include Russia, Belarus, Kazakhstan, Kyrgyzstan, and Armenia (Ayadi et al., 2004; Kremer, 1993).

Several studies have analyzed the potential of the EAEU as a platform for transformational processes. Researchers argue that the EAEU has the potential to become a driver of economic growth and modernization (Wang et al., 2019). Other scholars have focused on the role of the EAEU in facilitating regional economic integration. Data indicate that the EAEU's trade agreements have led to increased intra-regional trade and investment (Clemens & Kauffman, 2019).

Overall, the existing literature suggests that the EAEU has the potential to drive transformational processes in the region; however, its success will depend on the ability of its member states to overcome institutional and economic challenges.

It can also be noted, that the existence of a «middle-income trap» is still a controversial phenomenon (Agenor, 2017; Larson et al., 2016). The report of the London School of Economics and Political Science (2021) and the article of Glawe and Wagner (2016) provide an overview of theories, definitions, and countries affected by this problem.

The study focuses on the theory of Schumpeterian growth developed by Aghion (Aghion & Bircan, 2017; Aghion & Howitt, 1990; Aghion et al., 2021). Aiyar et al. (2013), Georgiev et al. (2017), and the United Nations (2020) provide a similar approach to analyze the development problems of the countries of Europe and Asia. Horn and Grugel (2018) coordinate middle-income trap problems with the prospects for sustainable development goals.

Russia like other developing countries has exhausted the potential for a commodity boom and high prices for hydrocarbon raw materials. The predominance of Russia's «forward participation» in the global value chain, demographic decline, etc. do not allow Russia to escape from the «middle-income trap» (Ashfaq et al., 2024; Aslund, 2013). Taking into account the regional specifics and the prevailing regional railroad transport infrastructure the study of the importance of railways for regional integration has been performed in a number of works (Liang et al., 2020; Nilsson & Delmelle, 2020; Pan et al., 2020; Yang et al., 2020). Liu (2019) analyzed how strengthening communication between European regions led to economic growth in 268 regions from 2000 to 2014 despite the decrease in the impact of classical growth factors.

Previously explored the problem of the «middle-income trap» (Dubovik & Degtyareva, 2015; Liou, 2024). The macroeconomic indicators for the period that has passed since the date of the formation of the EEU were analyzed and concluded that our past findings are still valid. Nevertheless, it was decided to correct our initial hypothesis by including results of the analysis of the economic complexity index and abilities of percolation theory as well as the «O-Ring Theory» for interpretation purposes.

It is worth noting that in 2024, the world order may undergo significant changes, with more countries joining BRICS and experiencing economic growth. This opens up new opportunities for research and cooperation between countries and regions, which can bring significant benefits to all participants.

In this context, it is important to consider new approaches and models of economic development that respond to current realities and challenges. Studying the dynamics of BRICS development and other new economic blocs can provide valuable lessons for avoiding the middle-income trap and promoting the creation of a stable and prosperous economic environment. However, historical analysis and the experience of past economic models can also be useful for understanding and avoiding potential mistakes in the future. Therefore, it is important to maintain a balance between studying the past and adapting to new challenges to ensure sustainable and resilient economic development in the future.

Materials and Methods

The research used a basis of historical and evolutionary analysis, comparison, mathematical statistics, and econometrics to study the dynamics of the gross domestic product of the EEU countries. The informational basis for the study was the publicly available statistical data presented on the Internet (Eurasian Bank of Development, 2020; Eurasian Economic Commission, 2021; International Monetary Fund, 2021; Our World in Data, 2019; World Bank Open Data, 2021; World Data Atlas, 2021).

Table 1 provides statistical data for macroeconomic analysis:

A correlation analysis was carried out based on the Pearson correlation coefficient (Fieller et al., 1957):

Table 1 GDP per capita, current prices (U.S. dollars per capita)

Country	1992	1993	1994	1995	1996	1997
Armenia	31.321	247.884	196.98	399.576	503.774	521.869
Belarus	1252.792	1114.104	1533.721	1034.931	1429.059	1396.112
Kazakhstan	168.645	304.849	751.98	1061.475	1358.804	1459.418
Kyrgyzstan	207.976	148.155	245.851	329.934	396.495	379.056
Russia	618.067	1322.006	1979.411	2264.343	2787.022	2935.03
Country	1998	1999	2000	2001	2002	2003
Armenia	608.415	597.241	620.638	692.287	779.122	923.387
Belarus	1514.669	1210.965	1079.61	1283.273	1524.49	1873.667
Kazakhstan	1480.094	1132.124	1230.491	1491.653	1657.155	2062.289
Kyrgyzstan	344.404	258.467	280.635	309.913	323.343	382.888
Russia	1949.801	1427.307	1901.956	2255.253	2552.788	3197.573
Country	2004	2005	2006	2007	2008	2009
Armenia	1180.399	1628.063	2128.151	3079.031	3913.436	2911.763
Belarus	2450.9	3221.463	3968.753	4887.275	6581.175	5345.325
Kazakhstan	2862.502	3753.441	5261.026	6733.45	8349.287	7116.371
Kyrgyzstan	436.496	478.77	546.621	725.487	971.678	876.933
Russia	4403.962	5708.838	7426.005	9761.368	12464.24	9156.97
Country	2010	2011	2012	2013	2014	2015
Armenia	3121.778	3417.172	3575.529	3732.035	3889.004	3529.026
Belarus	6023.149	6472.739	6938.067	7977.147	8316.012	5941.24
Kazakhstan	9005.039	11552.57	12300.18	13789.17	12713.56	10435.17
Kyrgyzstan	884.846	1131.471	1189.517	1295.225	1292.621	1132.843
Russia	11431.15	14306.43	15287.97	15928.7	14007.51	9257.935
Country	2016	2017	2018	2019	2020	
Armenia	3524	3868.906	4195.963	4604.772	4155.273	
Belarus	5022.472	5757.286	6322.317	6798.349	6398.87	
Kazakhstan	7662.006	9186.712	9749.069	9750.427	8732.644	
Kyrgyzstan	1131.841	1254.51	1321.954	1323.465	1146.393	
Russia	8723.523	10,724	11261.72	11511.51	10037.24	

Source: International Monetary Fund (2021)

$$r_{xy} = \frac{cov(x,\ y)}{SD_x\ \times\ SD_y} \tag{1}$$

and Spearman correlation coefficient:

$$r_{s_{xy}} = \frac{cov(rank_x,\ rank_y)}{SD\,(rank_x) \times\ SD\,(rank_y)} \tag{2}$$

The Pearson correlation coefficient was used in our research since the studied variables (GDP) do not have an ordinal scale.

Calculations were carried out in the R language (in the RStudio environment) using the «easystats» software packages (Makowski et al., 2020) (presented in Appendix).

The calculated values of the Pearson correlation coefficient (Table 2) indicate an approximately equal dependence of the GDP of the EEU countries and the GDP of Russia.

We took into account the prescriptive, normative nature of the econometrics methodology (Ziliak & McCloskey, 2008), as well as the problematic comparison and reproducibility of results (Liebman, 2008) presenting the results of correlation analysis of data in our work).

The economic complexity index is determined based on the prevalence of expressing recursion (Hausmann et al., 2011; Hidalgo & Hausmann, 2009):

$$k_{c,0} = \frac{1}{k_{c,0}} \sum{}_p M_{cp} \frac{1}{k_{p,0}} \sum{}_{c'} M_{c'p} k_{c',n-2} = \sum{}_{c'} k_{c',n-2} \sum{}_p \frac{M_{c'p} M_{cp}}{k_{c,0} k_{p,0}} = \sum{}_{c'} k_{c',n-2} \widetilde{M}^C_{c,c'} \tag{3}$$

$$\widetilde{M}^C_{c,c'} \equiv \sum{}_p \frac{M_{cp}\, M_{c'p}}{k_{c,0} k_{p,0}} \tag{4}$$

We used vector notation, where $\overrightarrow{k}_n - vector, c»$ are $k_{c,n}$:

$$\overrightarrow{k}_n = \widetilde{M}^C \times \overrightarrow{k}_{n-2} \tag{5}$$

where $\widetilde{M}^C$ – a matrix, c are $\widetilde{M}^C_{c,c'}$.

If n is infinite, then the equation results in a distribution (scalar factor):

$$\widetilde{M}^C \times \overrightarrow{k} = \lambda \overrightarrow{k} \tag{6}$$

Table 2 A correlation coefficient value (Pearson): EEU countries / Russia / EU

	Russia	EU
Armenia	0.9345104	0.9605379
Belarus	0.979467	0.9561961
Kazakhstan	0.9825186	0.9230231
Kyrgyzstan	0.9347083	0.9177746

where $\overrightarrow{k}$ – eigenvector $\widetilde{M}^{C}$.

Therefore, an economic complexity index (ECI) is an eigenvector corresponding to the second eigenvalue of the matrix $\widetilde{M}^{C}$.

We suggest that it is possible to determine the prevalence of exports of a particular product in the world as well as the degree of diversification of the economy of a particular country using the matrix $\widetilde{M}^{C}$. The dominance of extractive institutions focused on extracting resource rent in countries with a predominance of commodity exports hinders the deepening of diversification of their economies.

The description of integration processes in EEU may be performed by the theory of percolation processes that occur an action of a binding force equal to the number of interconnections between the economic entities of the EEU countries and the ability of other economic entities of the EEU countries to perceive the integrating impact. Such a description is reduced to the construction of a rectangular lattice where cells are economic actors (subjects of integration processes). The Hoshen-Kopelman algorithm can be used as a basis for an analysis of the probability of filling said cells and a distribution of integration bonds as well as the assessment of a distribution of a fractal cluster (and sub-clusters of a percolation fractal). The disadvantage of this method is that a flow in a lattice is carried out along the nodes/bonds. However, economic systems do not have a lattice structure, therefore, it is necessary to use other approaches, for example, a potential model.

Results

Table 3 presents data on the dynamics of GDP PPP in the countries of the EEU for 1993–2018, i.e. for the period both before and after the formation of the Union.

A visualization of the data used in Table 3 makes the trend of changes in the specified macroeconomic indicator clearer:

The logarithm of the GDP PPP of the EEU countries (Figs. 1 and 2) presents data more smoothing and without outliers observed in certain periods:

Table 4 provides data on the EEU countries' GDP dynamics.

Based on the construction of a boxplot for the GDP of countries (Fig. 3), it was concluded that Russia and Kazakhstan are the most similar countries in the Eurasian Economic Union, allowing for further comparative analysis of these states.

A comparison of Russia and Kazakhstan is also justified based on the analysis of the structure of exports and imports of these countries (Figs. 4 and 5).

We state that the dynamics of exports of Russia and Kazakhstan are determined by exogenous factors, namely the dynamics of the EU's GDP (the influence of China remains outside our article). This confirms the significant positive correlation (taking into account the time lag) between these indicators, as noted earlier (Ushkalova & Nikitina, 2019).

It is easy to find out that raw materials dominate in exports of Russia and Kazakhstan; machinery and equipment dominate in imports. This is radically different from the structure of the world exports (Fig. 6):
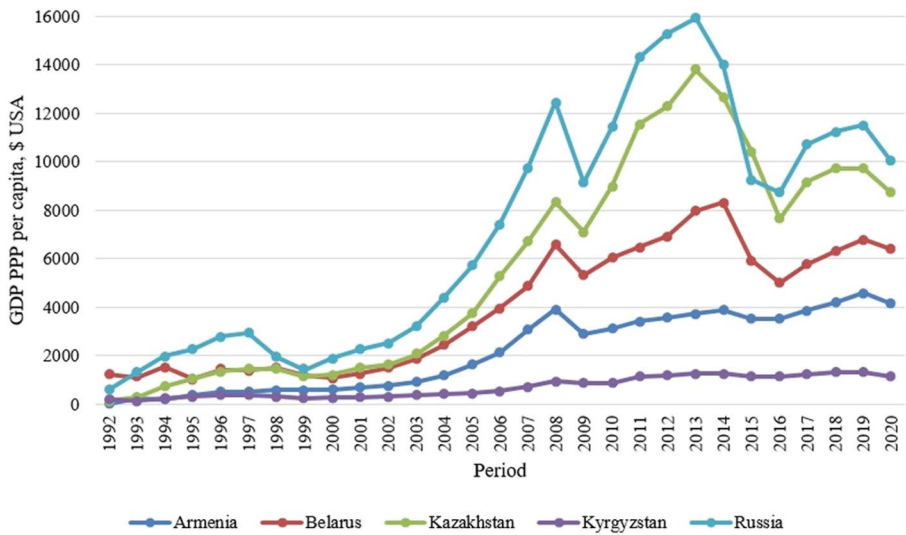
Table 3 GDP PPP per capita of EEU countries, $ USA

	Armenia	Belarus	Kazakhstan	Kyrgyzstan	Russia
1993	4.130	9.077	9.174	3.765	9.789
1994	4.393	7.932	8.179	2.994	8.744
1995	4.703	6.994	7.674	2.776	8.586
1996	4.811	7.128	7.827	2.902	8.479
1997	4.836	7.885	8.094	3.115	8.813
1998	4.994	8.482	8.089	3.106	8.557
1999	5.000	8.690	8.421	3.144	9.340
2000	5.140	9.111	9.309	3.246	10.553
2001	5.458	9.462	10.589	3.358	11.391
2002	6.082	9.870	11.640	3.299	12.259
2003	6.743	10.493	12.726	3.465	13.521
2004	7.230	11.616	13.930	3.632	14.881
2005	8.007	12.630	15.234	3.554	16.243
2006	8.799	13.793	16.787	3.595	18.008
2007	9.713	14.857	18.181	3.831	20.018
2008	10.081	16.224	18.666	4.047	21.563
2009	8.399	16.089	18.751	4.076	20.336
2010	8.331	17.172	19.965	3.978	21.737
2011	8.465	17.918	21.302	4.142	23.130
2012	9.077	18.251	22.089	4.104	23.931
2013	9.385	18.464	23.131	4.509	24.224
2014	9.735	18.822	23.841	4.644	24.387
2015	10.042	18.136	23.850	4.754	23.691
2016	10.080	17.628	23.842	4.879	23.635
2017	10.859	18.113	24.557	5.056	24.043
2018	11.454	18.727	25.308	5.177	24.669

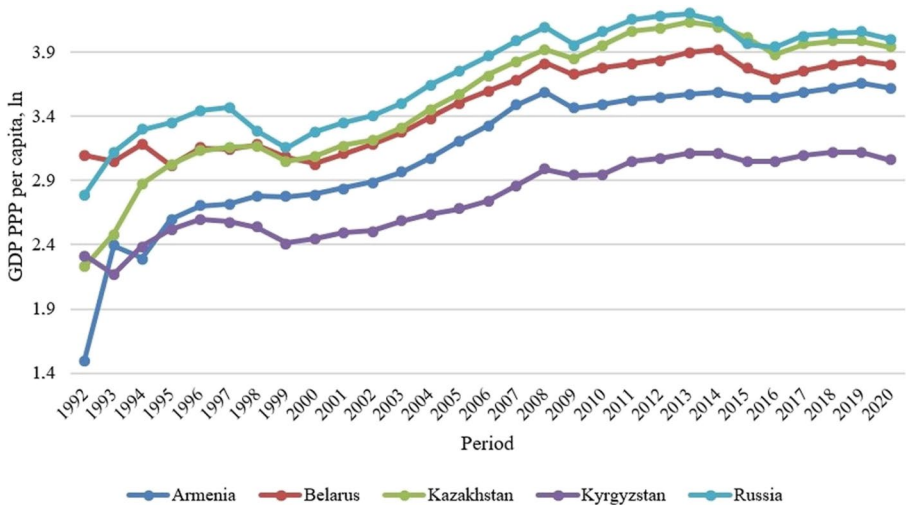Source: World Data Atlas (2021)

This export/import structure was inherited by Russia and Kazakhstan from the USSR, whose involvement in global production chains was referred to as the so-called «forward participation»– the export of raw materials, intermediate goods, and services that are used by more developed countries to create products with high shares of added value. In contrast, a high «backward participation» indicates that exports are dominated by products with a high level of value-added, equipment, technologies, etc.

About 30% of Russian exports are products of «forward participation». It is the highest level of this indicator among the developed economies (China 17.5%, India 14.9%, and USA 22.2%). The «backward participation» of Russia in the global value chain is about 10% which is significantly lower compared to other countries (China, India, and Turkey - about 16%) (World Bank, 2021).

We assume that it is rational to analyze the EEU countries' export structure using the theory of complexity. The position of a particular country in the «index of complexity» is determined by the presence of complex diversified products and technologies in the structure of exports and domestic consumption. Table 5 presents data from the Harvard Growth Lab's Atlas of Economic Complexity:

Fig. 1 The GDP PPP per capita ($ USA, current prices) of EEU countries. Own representation based on data from the World Data Atlas (2021)

Fig. 2 The GDP PPP (ln) per capita ($ UDS, current prices) of the EEU countries. Own representation based on data from the World Data Atlas (2021)

As it was shown earlier in this paper the EEU countries' GDP changed differently after the formation of the Union. Therefore, the positions of these countries in the ranking of economic complexity also changed to varying degrees. Moreover, these changes are a continuation of the trends that had formed before the EEU's establishment (from 2010 particularly, after «the Great Recession»– Fig. 7):

Table 4 A growth rate of EEU countries» GDP PPP per capita, %

	Armenia	Belarus	Kazakhstan	Kyrgyzstan	Russia
1993	-14.054	-7.6	-9.2	-13.005	-8.7
1994	5.4	-11.7	-12.58	-19.807	-12.7
1995	8.033	-11.084	-8.2	-5.424	-4.1
1996	5.169	2.776	0.5	7.085	-3.608
1997	3.387	11.434	1.7	9.915	1.382
1998	6.271	8.442	-1.9	2.122	-5.345
1999	3.17	3.354	2.7	3.656	6.351
2000	5.853	5.76	9.8	5.443	10.046
2001	9.468	4.725	13.5	5.322	5.09
2002	14.807	5.045	9.8	-0.017	4.744
2003	14.052	7.043	9.3	7.03	7.349
2004	10.473	11.45	9.6	7.027	7.176
2005	14.113	9.441	9.7	-0.176	6.376
2006	13.198	9.998	10.7	3.103	8.154
2007	13.749	8.647	8.9	8.543	8.535
2008	6.948	10.248	3.3	7.566	5.248
2009	-14.15	0.164	1.2	2.886	-7.821
2010	2.2	7.75	7.3	-0.472	4.503
2011	4.7	5.55	7.4	5.956	5.066
2012	7.134	1.708	4.8	-0.088	4.024
2013	3.412	0.999	6.0	10.915	1.755
2014	3.607	1.651	4.2	4.024	0.736
2015	3.254	-3.83	1.2	3.876	-1.973
2016	0.195	-2.526	1.1	4.336	0.194
2017	7.518	2.532	4.1	4.74	1.826
2018	5.225	3.149	4.1	3.459	2.536
2019	7.582	1.222	4.5	4.468	1.342
2020	-4.455	-2.991	-2.694	-12.023	-4.116

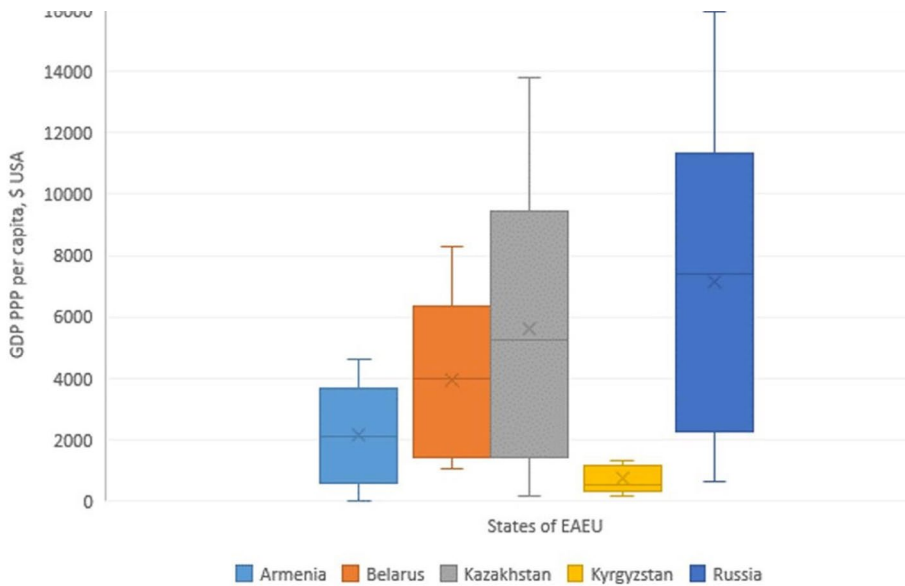Source: World Data Atlas (2021)

In our opinion, the complexity (diversification) of exports has great predictive potential both for studies of economic growth and for explaining the difference in income of various countries. The EEU countries are among average complexity economies and this indicator has not radically changed over the observed period. Therefore, it is not surprising that these same countries are considered middle-income states.

A structural analysis of the EEU countries' exports (Fig. 8) led us to the conclusion that the establishment of this Union did not influence the dynamics of mutual exports: Kyrgyzstan's exports increased by 0.1%, Kazakhstan's exports decreased by 1.1%, Russian exports also decreased by 1.09%.

The same conclusion was made for a non-significant change in the dynamics of the EEU countries' exports to non-EEU countries (Fig. 9).

An analysis of import data presented in Figs. 10 and 11 led us to the same opinion.

The creation of a common labor market was (and is) the postulated goal for establishing the Eurasian Economic Union. Migrant data flows were used (Figs.

Fig. 3 A boxplot of GDP PPP per capita of the EEU countries. Own representation based on data from the World Data Atlas (2021)

12 and 13) and found that Russia accepts disproportionately more labor migrants from the EEU countries than supplies its specialists to the labor markets of these countries. Note: an analysis of emigrants from Russia to countries of the EEU provides that these phenomena are the return of ethnic groups who had previously arrived in the Russian Federation from the countries of the Union in most cases.

Figure 13 presents the structure of migration to Russia from the Union countries: Kyrgyzstan is the leader, followed by Kazakhstan, Armenia, and Belarus.

The real wage difference in the EEU countries explains the dominance of migration from the Union countries to Russia. The lack of convergence between the economies of the Union due to this difference was determined. It is a striking contrast with the «Atlantic Economy» (OECD) after 1950 (Aghion & Williamson, 2004).

It is concluded that a proposed new approach to studying the dynamics of GDP of the EEU countries is based on applying the theory of percolation to integration processes as well as the theory of economic complexity. It may be appropriate to interpret the results of the analysis not from the standpoint of indicators of economic growth but the avoid the «middle-income trap» and «forward participation» of Russia in global value chains. It is expected that the use of an economic complexity theory, a percolation theory, and an «O-Ring Theory» is a promising research frame for macroeconomic analysis and interpretation of its results.

Fig. 4 A structure of Russian and Kazakh exports. Own representation based on data from the Eurasian Economic Commission (2021)

Discussion

The study investigates the dynamics of Gross Domestic Product (GDP) in EAEU countries and concludes that the EAEU has the potential to serve as a platform for significant transformational processes that could help member states overcome the middle-income trap. The theory of economic complexity was employed to assess the prevalence of certain product exports globally and the degree of economic diversification of specific countries. The analysis revealed that EAEU countries possess medium economic complexity, and this has not significantly changed over the observed period.

Additionally, the theory of percolation was used to describe the integration processes within the EAEU. It is demonstrated that the creation of a common labor market was (and remains) a stated objective for the establishment of the EAEU. However, Russia disproportionately receives a larger number of labor migrants from

Fig. 5 A structure of Russian and Kazakh imports. Own representation based on data from the Eurasian Economic Commission (2021)

EAEU countries compared to the number of its specialists sent to the labor markets of these countries.

Alternative solutions, such as promoting innovation and technological development, enhancing human capital, supporting small and medium-sized enterprises, implementing economic reforms, fostering international cooperation, and developing infrastructure, are proposed to overcome the middle-income trap in EAEU countries and achieve sustainable economic growth (Fedyunina et al., 2020). These measures aim to diversify economies, reduce dependence on raw material exports, create conditions for innovative development and technological progress, and improve the global competitiveness of EAEU countries. Furthermore, they are expected to enhance the quality of life, reduce socio-economic inequalities, and strengthen regional integration and cooperation among EAEU countries (Nguyen et al., 2020; Nguyen & Su, 2021).

The study underscores the importance of reassessing approaches to integration and economic development within the EAEU, as current development models fail to deliver the necessary levels of economic growth and innovation progress. There is a
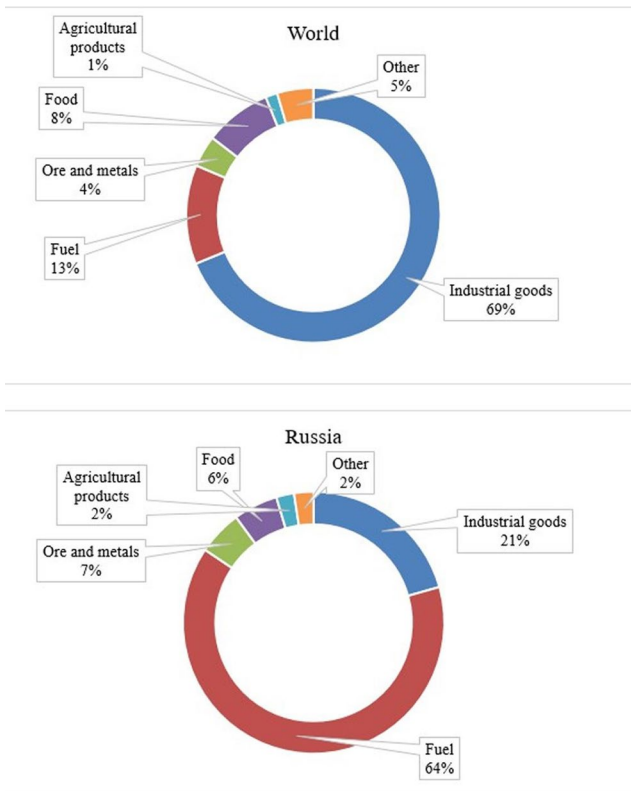
Fig. 6 A structure of world and Russian exports, %. Own representation based on data from the World Bank (2021)

Table 5 Country Economic Complexity Rankings

Rank	Country	Country Economic Complexity Index (ECI)	Change in 5 years (2014–2019)	Complexity Outlook Index (COI)
76	Armenia	-0.27	↓6	-0.66
31	Belarus	0.83	↓1	1.03
78	Kazakhstan	-0.32	↑6	-0.39
66	Kyrgyzstan	-0.04	↑1	0.55
52	Russia	0.12	↑10	0.33

Source: Atlas (2021)

need to revise priorities and integration strategies to ensure more effective resource utilization, stimulate innovation and technological development, and enhance the competitiveness of EAEU countries in the global market. Re-evaluating integration and economic development approaches is also crucial for overcoming existing limitations and barriers that hinder closer cooperation among EAEU member states. This may involve reforming institutions, developing infrastructure, strengthening
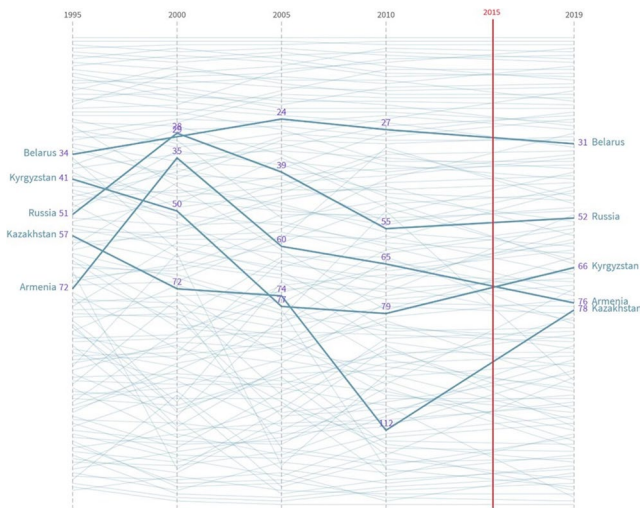
Fig. 7 Country Complexity Comparisons. Source: Atlas (2021)

human capital, and creating a more favorable business environment (He et al., 2020; Oloyede et al., 2021).

Haddad (2020) emphasizes the importance of diversifying economies and reducing dependency on raw material exports for EAEU countries. He also notes that EAEU integration should focus on creating conditions for innovative development and technological progress. The findings of this study corroborate other authors' conclusions regarding the need to reassess integration and economic development approaches within the EAEU. However, the study also identifies some differences in approaches to addressing these issues. For instance, Rekiso (2017) and other authors highlight the significance of government support for innovation development, whereas this study emphasizes the importance of creating a favorable business climate and stimulating the private sector.

The conducted research has the potential to make a significant contribution to both theoretical knowledge and practical application. It expands our understanding of the effectiveness and feasibility of establishing regional economic unions and analyzes the causes and consequences of the challenges faced by EAEU member states.

The middle-income trap is a challenge that can be overcome through investments in innovation, education, and the development of human capital, enabling a country to advance to a new level of economic growth. This perspective encourages proposals for alternative solutions:

1. Stimulating innovation and technological development: Investing in research and development of new technologies can foster economic growth and competitiveness.
2. Human capital development: Focusing on education, skills, and population health can increase labor productivity and create conditions for higher-paying jobs.
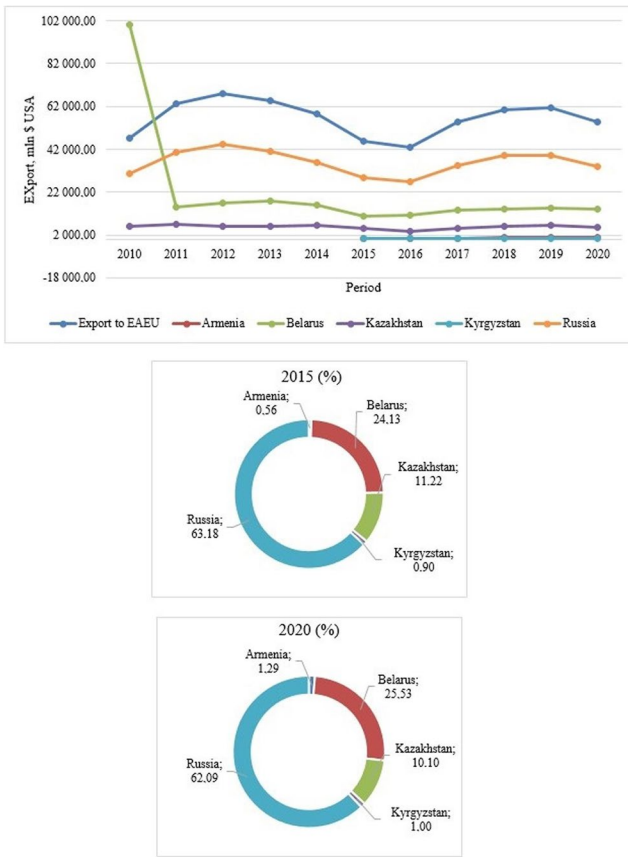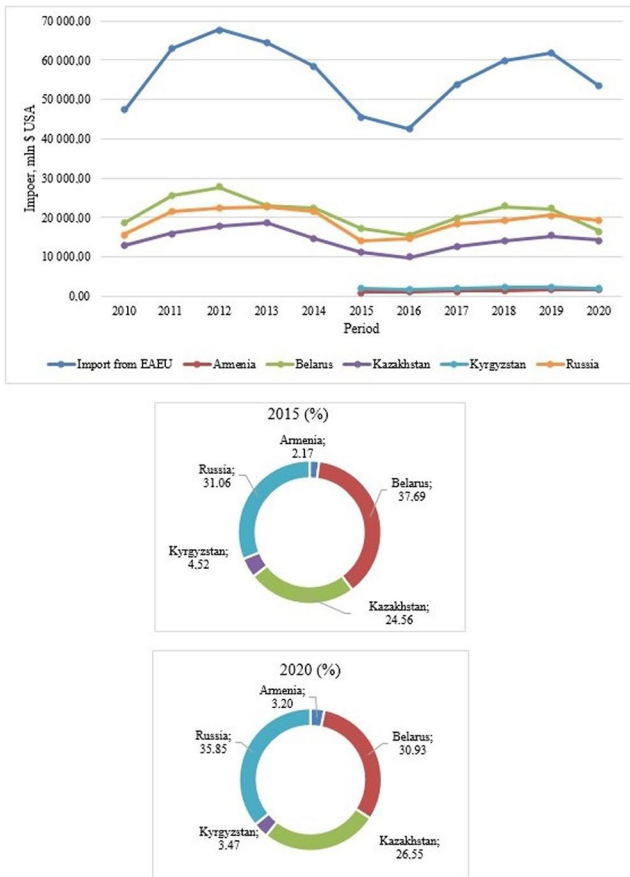
Fig. 8 Exports of the EEU countries to the Union countries. Own representation based on data from Eurasian Economic Commission (2021)

3. Supporting small and medium-sized enterprises (SMEs): SME support can facilitate the development of new sectors and ensure economic diversification.
4. Economic policy reform: Effective governance, combating corruption, and creating a favorable business environment can contribute to economic growth.
5. International cooperation: Collaboration with other countries and international organizations can provide access to new markets and resources.
6. Infrastructure development: Investments in transportation, energy, and information technologies can enhance competitiveness and attractiveness for investors.
7. Balanced trade: Promoting export development and expanding trade relations can increase incomes and stimulate economic growth.

These alternatives can be utilized collectively or individually to achieve the goals of income enhancement and overcoming the middle-income trap.
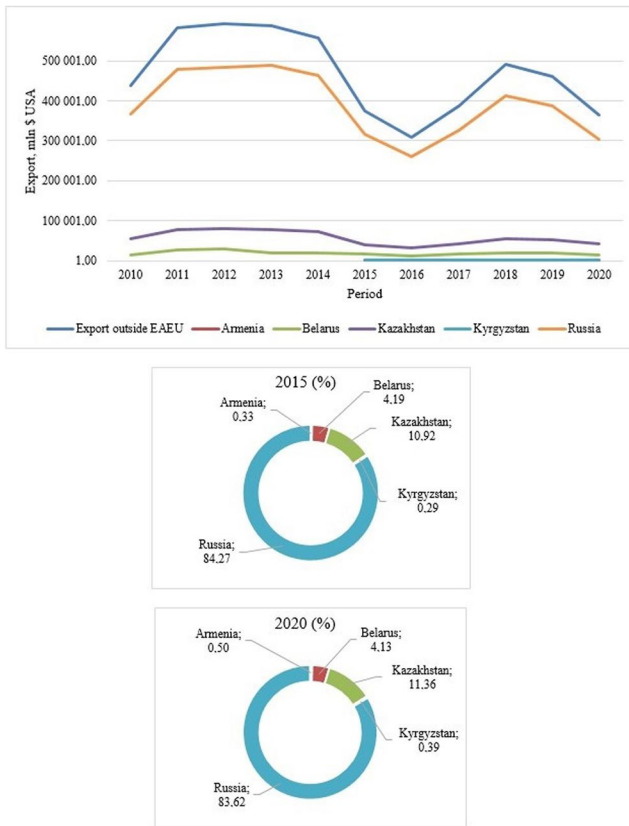
Fig. 9 Exports of EEU member countries to non-EU countries. Own representation based on data from Eurasian Economic Commission (2021)

The potential contribution of this research to knowledge in theory and policy application is significant. Firstly, it expands understanding of the effectiveness and feasibility of creating regional economic unions, with a focus on the Eurasian Economic Union. Secondly, the research provides an analysis of the causes and consequences of the problems faced by Eurasian Economic Union countries, such as customs barriers, conflicts in natural gas pricing, and depopulation. This may serve as a basis for developing political strategies and recommendations to strengthen integration, reduce trade barriers, and enhance socio-economic development. Additionally, the research may influence the formulation of political decisions regarding the support and development of regional economic blocs, as well as stimulate further research in this area. This is crucial for the development of strategies to ensure sustainable and balanced development of regions and countries within the Eurasian space.
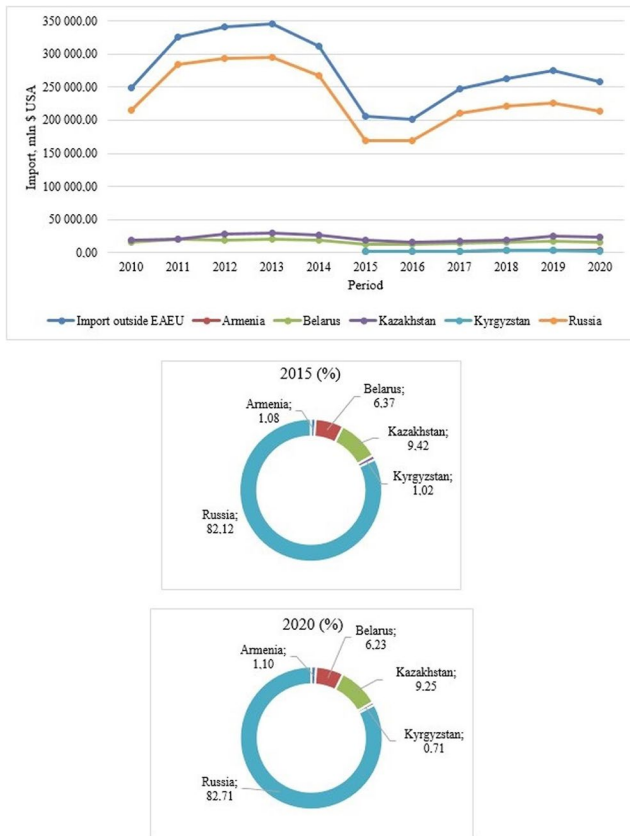
Fig. 10 Imports to the EEU countries from the Union countries. Own representation based on data from Eurasian Economic Commission (2021)

Conclusions

The study reveals that the dynamics of GDP at Purchasing Power Parity (PPP) in the Eurasian Economic Union (EAEU) exhibit different trends before and after the formation of the Union. It has been established that Russia and Kazakhstan are the most similar countries within the EAEU, allowing for further comparative analysis of these states. The export dynamics of Russia and Kazakhstan are influenced by exogenous factors, particularly the dynamics of the GDP of the European Union, which confirms a positive correlation between these indicators.

The structure of exports and imports for Russia and Kazakhstan differs significantly from the structure of global exports, a consequence of their Soviet legacy. It was found that approximately 30% of Russia's exports consist of "forward participation" products, which is the highest proportion among developed economies.

Fig. 11 Imports from EEU countries from non-Union countries. Own representation based on data from Eurasian Economic Commission (2021)

The analysis indicates that EAEU countries are classified as medium-complexity economies, with this metric showing no radical changes over the observed period. Additionally, it was found that the formation of the EAEU did not impact the dynamics of mutual exports among the Union's member states, nor did it affect export dynamics to non-EAEU countries. While the establishment of a common labor market was one of the objectives of creating the EAEU, in practice, Russia hosts a majority of labor migrants from EAEU countries rather than supplying its specialists to the labor markets of these countries.

However, the global economy is evolving rapidly, with new players such as China and Russia gaining prominence. Therefore, it is important to consider these changes and seek opportunities for cooperation and interaction between EAEU countries and other regions, such as BRICS, Iran, Kazakhstan, and others. Additionally, the world is moving towards a multipolar order with significant positive economic implications, necessitating readiness for change and exploration of collaborative opportunities.
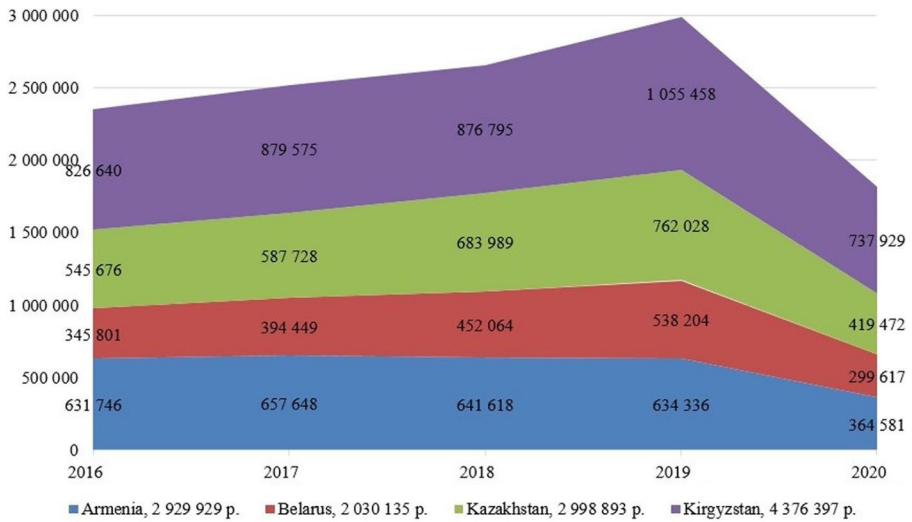
Fig. 12 A dynamics of migration to Russia from the EEU countries. Own representation based on the Ministry of Internal Affairs of the Russian Federation (2021)
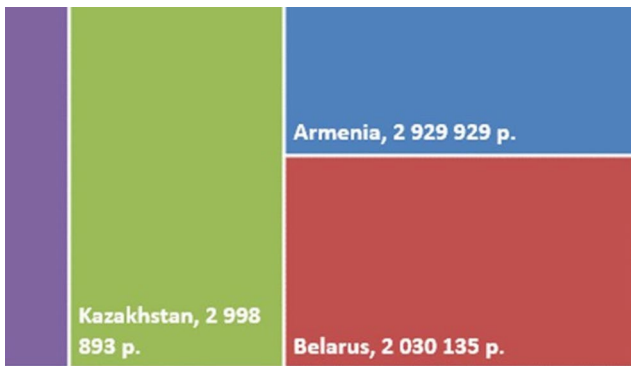
Fig. 13 A structure of immigration to Russia from the EEU countries, 2015–2020. Own representation based on the Ministry of Internal Affairs of the Russian Federation (2021)

As a result, the study proposes a new approach to analyzing the dynamics of GDP in EAEU countries, based on the application of percolation theory to integration processes, as well as economic complexity theory. This approach could assist EAEU countries in avoiding the "middle-income trap" and advancing their economies towards greater diversification and innovation.

Appendix

RStudio Code (data used from Table 1)
library(easystats)

```
#Data for analysis
 ARM  <- c(31.321, 247.884, 196.98, 399.576, 503.774, 521.869, 608.415,
597.241, 620.638, 692.287, 779.122, 923.387, 1180.399, 1628.063, 2128.151,
3079.031, 3913.436, 2911.763, 3121.778, 3417.172, 3575.529, 3732.035, 3889.004,
3529.026, 3524.00, 3868.906, 4195.963, 4604.772, 4155.273)
 BLR  <- c(1252.792, 1114.104, 1533.721, 1034.931, 1429.059, 1396.112,
1514.669, 1210.965, 1079.61, 1283.273, 1524.49, 1873.667, 2450.9, 3221.463,
3968.753, 4887.275, 6581.175, 5345.325, 6023.149, 6472.739, 6938.067, 7977.147,
8316.012, 5941.24, 5022.472, 5757.286, 6322.317, 6798.349, 6398.87)
 KAZ <- c(168.645, 304.849, 751.98, 1061.475, 1358.804, 1459.418, 1480.094,
1132.124, 1230.491, 1491.653, 1657.155, 2062.289, 2862.502, 3753.441, 5261.026,
6733.45,  8349.287,  7116.371,  9005.039,  11552.574,  12300.184,  13789.172,
12713.564, 10435.17, 7662.006, 9186.712, 9749.069, 750.427, 8732.644)
 KGZ  <- c(207.976, 148.155, 245.851, 329.934, 396.495, 379.056, 344.404,
258.467, 280.635, 309.913, 323.343, 382.888, 436.496, 478.77, 546.621, 725.487,
971.678, 876.933, 884.846, 1131.471, 1189.517, 1295.225, 1292.621, 1132.843,
1131.841, 1254.51, 1321.954, 1323.465, 1146.393)
 RUS <- c(618.067, 1322.006, 1979.411, 2264.343, 2787.022, 2935.03, 1949.801,
1427.307, 1901.956, 2255.253, 2552.788, 3197.573, 4403.962, 5708.838, 7426.005,
9761.368, 12464.244, 9156.97, 11431.148, 14306.432, 15287.967, 15928.699,
14007.509, 9257.935, 8723.523, 10723.996,
 11261.716, 11511.507, 10037.239)
 EU <- c(18246.609, 16340.128, 17296.298, 19547.146, 19842.306, 18201.994,
18745.16, 18624.437, 17062.735, 17301.218, 18866.845, 23112.538, 26469.091,
27528.973, 29280.352, 33817.753, 37318.372, 33698.988, 33244.584, 35908.051,
33311.904, 34746.002, 35493.882, 30652.249,
 31352.626, 33257.679, 35944.307, 35127.435, 34047.123)
#Make a data frame
CORR.DATA <- c(ARM, BLR, EU, KAZ, KGZ, RUS)
#Correlation EEU to EU - Pearson
cor(ARM, EU, method = "pearson")
cor(BLR, EU, method = "pearson")
cor(KAZ, EU, method = "pearson")
cor(KGZ, EU, method = "pearson")
cor(RUS, EU, method = "pearson")
> #Correlation EEU to EU - Pearson
> cor(ARM, EU, method = "pearson")
[1] 0.9605379
> cor(BLR, EU, method = "pearson")
[1] 0.9561961
> cor(KAZ, EU, method = "pearson")
[1] 0.9230231
> cor(KGZ, EU, method = "pearson")
[1] 0.9177746
> cor(RUS, EU, method = "pearson")
[1] 0.9454607
```

```
> #Correlation EEU to Russia - Pearson (Results)
> cor(BLR, RUS, method = "pearson")
[1] 0.979467
> cor(ARM, RUS, method = "pearson")
[1] 0.9345104
> cor(KAZ, RUS, method = "pearson")
[1] 0.9825186
> cor(KGZ, RUS, method = "pearson")
[1] 0.9347083
#Correlation EEU to EU - Spearman
cor(ARM, EU, method = "spearman")
cor(BLR, EU, method = "spearman")
cor(KAZ, EU, method = "spearman")
cor(KGZ, EU, method = "spearman")
cor(RUS, EU, method = "spearman")
#Correlation EEU to EU - Spearman (Results)
> cor(ARM, EU, method = "spearman")
[1] 0.8985222
> cor(BLR, EU, method = "spearman")
[1] 0.9054187
> cor(KAZ, EU, method = "spearman")
[1] 0.873399
> cor(KGZ, EU, method = "spearman")
[1] 0.9004926
> cor(RUS, EU, method = "spearman")
[1] 0.920197
#Correlation EEU to Russia - Spearman
cor(BLR, RUS, method = "spearman")
cor(ARM, RUS, method = "spearman")
cor(KAZ, RUS, method = "spearman")
cor(KGZ, RUS, method = "spearman")
> #Correlation EEU to Russia– Spearman (Results)
> cor(BLR, RUS, method = "spearman")
[1] 0.953202
> cor(ARM, RUS, method = "spearman")
[1] 0.8871921
> cor(KAZ, RUS, method = "spearman")
[1] 0.953202
> cor(KGZ, RUS, method = "spearman")
```

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Data Availability Data will be available on request.

Declarations

Ethics Approval Not applicable.

Informed Consent Not applicable.

Conflict of Interest Authors declare that they have no conflict of interests.

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