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THE NEXUS BETWEEN EDUCATION AND ITS DETERMINANTS: A CASE STUDY OF THE EURASIAN ECONOMIC UNION

Abstract

The EAEU policy as an international organization of regional economic integration determines the inextricable context between deepening integration processes and achieving sustainable green growth. The commitment of the EAEU countries to the principles of the green economy is enshrined in their National Sustainable Development Strategies until 2030 and confirms green development as a strategic priority based on national characteristics and global challenges. The authors of the article analyzed their mutual influence as new solutions aimed at establishing and substantiating the relationship between indicators of environmental quality change (GDP per capita index, carbon emission, urban population, trade indices, energy consumption per capita, level of public administration) and education using the example of the EAEU member states. As new results, the mutual influence of indicators affecting changes in the quality of the environment and education is shown in the framework of the formation of a methodology for measuring their correlation, using the example of an integrated facility – the EAEU. The assessment of the conditions for the green development of the EAEU countries was carried out for the period 1996–2022. The results of the study showed ambiguous indicators and effects of the influence of the assessed variables on education in the country context, but allowed us to identify general trends in the green economy and substantiate the country's educational opportunities and prospects in the context of green development.

Keywords: green economy, education, sustainable development, environmental quality, customs union, government efficiency, pollution.

Introduction

The current state of the economy on a global scale is characterized by the formation of a new global economic model of green (sustainable) development. The specificity of the concept of this model is manifested in the harmonious coordination between the economic, social and environmental aspects, based on the general principles of sustainable development of the state. The member countries of the Eurasian Economic Union (hereinafter referred to as the EAEU, the Union) are in solidarity with the majority of states in the need to develop a "green economy" in the interests of raising the standard of living of their population, on the one hand, with the aim of ensuring sustainable development and inclusive "green" growth, on the other.

The policy of the EAEU as an international organization of regional economic integration determines the inseparable context between the deepening of integration processes and the achievement of sustainable green growth. The commitment of the EAEU member states (Kazakhstan, Armenia, Belarus, Russia and Kyrgyzstan) to the principles of a green economy is enshrined in national program documents, including the National Strategies for Sustainable Development until 2030, confirming green development as a strategic priority based on national characteristics and global challenges [1].

The Union's development objectives are reflected in the UN 2030 Agenda for Sustainable Development [2]. To identify changes and ways to advance towards goals and objectives, the document provides a list of indicators reflecting the relevant development vectors: environmental (26 indicators), economic (39 indicators), social (41 indicators) and sustainable (14 indicators) [3]. However, the proposed set of indicators does not reflect the extent of needs and opportunities and does not fully clarify the connection with the basic principles of sustainable development. Recognizing the interdependence of socio-economic systems with the environment, when analyzing sustainable development, it is important that the units of measurement and coordinates of sustainability be invariant to change. Consequently, the search for important coordinates of sustainability cannot be limited to a greater extent by the economic system and requires new approaches and solutions [4].

One of the problems that is considered in this study is the problem of improving the quality of the environment through the influence of higher education and identifying the relationship between them. The author's position is based on increasing the role of education in the development of the "green economy" as a sphere responsible not only for obtaining knowledge and professional qualifications, but also for the priority of forming needs that correspond to the principles of sustainable development. In modern literature, the relationship between education and the environment is insufficiently covered, with the obvious multifaceted influence of education on "green" processes [5]. Thus, publications of the United Nations Educational, Scientific and Cultural Organization focus on the connection between climate change and human activity and note the possibilities of education to help identify the causes and consequences of such changes and mitigate their impact [6].

Some authors in their studies on the contribution of education to solving environmental problems note that "education expands access to various sources of information that allow a person to understand unfamiliar and complex environmental problems. Education also increases the willingness to implement products that use renewable energy sources." [7]. In particular, studies claim that "people with high income and high levels of education are more involved in waste recycling activities compared to people with low income and low levels of education. Incorrect waste management practices can lead to water and environmental pollution" [8]. In addition, a link is noted between education and environmental protection practices, and the influence of human capital on increasing productivity, energy efficiency, and the willingness to implement "green" technologies in industry, households, and transport is demonstrated [9].

The authors' position on the importance of identifying the relationship between education and the environment in the context of the development of a green economy is supported by studies of the role of higher education. It is important to note that "education plays an important role in ensuring sustainable development, preparing people for "green" employment and in the educational behavior of consumers or producers in a "green" economy" [10]. Universities are becoming privileged places where the transformation of people and society takes place, allowing them to acquire new (green) competencies that people need for a sustainable life at the personal, professional and social levels [11]. Consequently, universities are becoming key agents of green change, forming the labor skills needed in the future low-carbon economy [12].

Thus, understanding how education interacts with the environment and influences its quality is an interesting direction of research, which we pursue in this article.

As new solutions aimed at establishing and substantiating the relationship between the need to improve the quality of the environment in the context of the development of education using the example of the EAEU member countries, the authors conducted an analysis analyzing an impact of the variable of interest on education level.

Studies reflecting the impact of indicators and indices, including environmental indices, on education also do not fill the gaps in the literature and seem insufficient to assess the coordinates of interaction between education and the environment. The independent variables identified by the

authors that influence the level of education development will allow for the formation of a systemic approach to assessing the sustainability of development at the country level.

The novelty of the article presented by the authors is determined by the absence in modern literature of studies that consider the EAEU as a complex object for identifying the relationships between specified determinants and the development of education in the context of the formation of a methodology for measuring their long run relationships.

Materials and methods

To empirically analyze the long-run and short-run relationships among the variables of interest we are using the following equation:

$$e_t = a_0 + a_1 c_t + a_2 l_t + a_3 y_t + a_4 g_t + a_5 u_t + a_6 t_t + \varepsilon_t \quad (1)$$

Where et is the dependent variable that represent education index, following independent variables c_t – carbon emissions, l_t – electricity consumption per capita, y_t – GDP per capita, g_t – the government efficiency index, u_t – urban population index, t_t – trade openness represented as a share of trade to GDP and finally is the error term. All variables are estimated in the natural logarithm forms.

It is expected that all of variables have positive impact on the educational level. In general carbon emissions increase with the higher level of industrialization, which may indirectly lead to an improvement of education quality.

Similar studies show the role of education in increasing the effectiveness of social responsibility in society to reduce pollutant emissions. The authors of these studies examine the impact of education on CO2 emissions, but do not consider the issues of the reverse effect. Findings indicate that primary education has no influence on CO2 emissions, in contrast secondary education appears to be a contributing factor to reducing them, albeit energy consumption is found to increase CO2 emissions. It has been discovered that a long-term inverse U-shaped relationship exists between CO2 emissions and economic growth [15]. Economic growth results in environmental degradation. In addition, the level of education has a positive effect on improving the economic situation of any economy, increasing environmental awareness. However, in the context of the environmental Kuznets curve, it is necessary to accelerate the process of economic growth of the country to reach the limit beyond which the environmental consequences of economic activity begin to decrease, and the impact on the environment is restored. In this case, the role of education, which can reduce the level of pollution, increases to the position of the main source of reducing the level of pollution in the country [15]. Russia and Kazakhstan, along with China, intend to become carbon neutral by 2060.

Higher electricity consumption enables an access to internet that expands possibilities for more studying fields. Economic growth appears to be a lasting solution for reducing environmental degradation in countries with high and upper-middle-income levels, whereas it actually exacerbates the problem in lower-middle-income and low-income nations. Environmental degradation is linked to energy consumption across all high-income brackets. Researchers believe that the direct impact of education can exacerbate environmental degradation in these groups. In addition, education may also have a moderating role, weakening the negative impact of energy consumption on environmental degradation in high- and upper-middle-income groups. However, in lower-middle-income and low-income groups, the moderating role of education will be exacerbated [17]. Considering the role of education in economic growth and the relationship between energy consumption and environmental degradation, it can be concluded that education is important for environmental sustainability due to its ability to encourage green behavior and attitudes, support energy-efficient products, and invest in green technologies. But on the other hand, education can also promote energy-intensive activities and dirty technologies, supporting an unecological lifestyle [17].

GDP per capita is associated with the higher income level and higher investments in human capital. Thus, global practice shows that over the past 50 years (according to UNESCO), higher education coverage in the world has changed by more than 3.5 times, while for economic reasons, educational inequality persists both between countries and within them. Based on the analysis of

117 countries, researchers have identified certain patterns [13]. For example, the largest educational gap is in countries with a below-average income level (according to the World Bank classification), which confirms the presence of greater opportunities for the wealthiest part of the population to go through the levels of education than less solvent people. In particular, it is noted that as the wealth of the country grows, this gap decreases. The next pattern is that higher education is more accessible to low-income citizens of rich countries than to wealthier ones in countries with low GDP per capita. An interesting question remains how educational inequality changes in the long term, and what impact does government education policy have on it. The search for an answer to this question can be traced in other studies, where, based on panel data for 1995–2018, Econometric models of the relationship between the dynamic indicators of GDP and education expenditures, both aggregate and individual by level of education, were constructed using time lags. The results showed a noticeable impact of aggregate education expenditures on GDP in the long term, but the obtained dependencies differ across countries. Thus, in rich countries, investments in all levels of education have a positive effect in the form of GDP growth, while in poor countries, a positive result only comes from investments in primary education. At the same time, investments in secondary and vocational education reduce GDP. This can be explained by the insufficient demand for high-level education in economies with poorly developed technologies and labor markets. Consequently, in countries with a low level of development and education, the diversion of public resources to finance vocational education in the short term can lead to a slowdown in economic growth. On the contrary, expanding the range of mass primary education contributes to rapid growth in the near future [14].

Government efficiency improves an infrastructure that improves a delivery of educational services. At the level of national economies, a common decision-making system is the tendency to separate economic, social and environmental factors. Governments should, where necessary, intensify efforts to clearly define the relationships between these areas. Since education is a strategic resource of any state, on which national development largely depends, clear goals are needed to assist in making political decisions and recommendations on practical management methods in the field of education. This applies primarily to the legal and legislative framework, the formation of educational policy, licensing and accreditation of educational institutions and organizations, processes related to the financing of education, the implementation of control and supervisory functions. Significant importance is given to the development of human resources and the digitalization of education. Countries should form key human resources in the context of taking into account environmental and sustainable development issues at various stages of the decision-making process and their implementation. To this end, at the country level, it is necessary to improve the effectiveness of education and training of technical and environmental personnel by including interdisciplinary approaches in the curricula of universities, introducing environmental standards into the educational process. This will allow for systematic professional training of government employees and specialist managers who meet the specific conditions of the country [19].

Increase in an urban population increases an access to educational services as educational infrastructure is constructed than in rural areas. Urbanization indicators influence the level of education in different ways. Firstly, migration from rural areas to cities increases the requirements for the level of education in rural educational institutions. In addition, the preparedness and qualifications of the workforce arriving in the cities directly depend on the organization of the educational process and the qualifications of teachers in the village. Secondly, sudden influxes to the cities increase the workload of urban educational institutions, which can lead not only to infrastructural changes, but also to a decrease in the effectiveness of education. Imbalance phenomena are also observed in rural education, since the costs of maintaining educational institutions and salaries of teachers remain at the same level, and the number of graduates and the quality of their education are declining. A study of the impact of urbanization processes on education has shown that there are both positive and negative consequences of this process [16].

Trade openness expands an access to foreign technologies and foreign experiences, encouraging investments in education. Globalization of world trade and increasing competition poses the challenge for countries to survive, which implies the need for the highest possible level of qualification of

workers, engineers, specialists of various profiles, which requires the creation of a more advanced education system in accordance with the best world standards, the establishment of broad international cooperation, and an increase in export-import relations. The impact of international trade on education is determined by a number of factors, although the dependence is not always characterized as straightforward. First of all, trade creates demand for qualified personnel and creates new jobs. Trade stimulates economic growth and leads to the emergence of new industries, spheres and companies that need specialists with new (green) knowledge and skills. Consequently, educational institutions are forced to adapt training programs to the current demands and challenges of the labor market [19].

Further, it should be noted that trade helps finance education. Thus, on the one hand, tax revenues from trading activities are redistributed to the needs of educational institutions and organizations of various directions and levels. On the other hand, trading companies are able to invest in the education of their workforce, sponsor various educational projects. An important factor in the influence of trade on education should be considered the promotion of trade in the dissemination of knowledge and cultural values, since it is trade that provides opportunities for the transformation of successful experience, best practices in the field of education between countries. In addition, there is a role and significance of trade through access to the global information network, in expanding and stimulating the horizons of students and their cognitive interest. Of particular importance is the fact that the positive impact of trade on education is realized only under the condition of strong government policy and the creation of a favorable investment environment.

The equation, identified as number 1, is utilized for the empirical examination of long-term associations and the dynamic interplay among the variables. The model was estimated using the bounds testing, or autoregressive distributed Lag (ARDL), approach to cointegration, which was developed by [20]. The process is utilized due to the following reasons. Estimating co-integration relationships is a straightforward process that involves using the ordinary least squares (OLS) method once the appropriate lag order for the model has been determined. A dynamic error correction model can be obtained from an ARDL model through a straightforward linear transformation as shown by Banerjee et al. in 1993. Furthermore, it does not necessitate a unit root test, allowing its use regardless of whether the model's regressors are purely stationary (I(0)), purely non-stationary (I(1)), or mutually cointegrated. The ARDL procedure will fail when dealing with series that are I(2), indicating they are integrated of order 2.

The test is more efficient in smaller sample sizes, specifically those with finite data. The ARDL approach possesses superior small-sample characteristics in comparison to the commonly employed methodologies of [21], [22], and the co-integration methods developed by [23].

The ARDL approach consists of two steps in order to estimate the long-run relationship [20]. The initial step entails investigating whether there are long-run correlations between all variables within an equation, while the subsequent step involves calculating the long-run and short-run coefficients of that same equation. We execute the second step provided that a co-integration relationship was identified in the first step. The equation in question is represented in the form of an ARDL model, as specified in equation (1):

$$\Delta e_t = b_0 + b_1 e_{t-1} + b_2 c_{t-1} + b_3 l_{t-1} + b_4 y_{t-1} + b_5 g_{t-1} + b_6 u_{t-1} + b_7 t_{t-1} + \\ + \sum_{i=1}^{m} b_{8i}\,\Delta e_{t-i} + \sum_{i=1}^{m} b_{9i}\,\Delta c_{t-i} + \sum_{i=1}^{m} b_{10i}\,\Delta l_{t-i} + \sum_{i=1}^{m} b_{11i}\,\Delta y_{t-i} + \sum_{i=1}^{m} b_{12i}\,\Delta g_{t-i} + \sum_{i=1}^{m} b_{13i}\,\Delta u_{t-i} \\ + \sum_{i=1}^{m} b_{14i}\,\Delta t_{t-i} + \epsilon_{it} \qquad (2)$$

where b_1, b_2, b_3, b_4, b_5, b_6 and b_7 are long run coefficients, m is the number of lags, b_0 is the drift, and ϵ_{it} are the white noise errors, i = 1-5, are member states of the EAEU.

To examine the cointegration presence we employ the null of no cointegration (H_0: $b_1=b_2=b_3=b_4=b_5=b_6=b_7=0$), against the alternative hypothesis of cointegration (H_1: $b_1\neq b_2\neq b_3\neq b_4\neq b_5\neq b_6\neq b_7\neq 0$), for each country. The ARDL bounds testing approach examines long-run interdependencies among the variables employing OLS estimation.

The ARDL cointegration approach uses asymptotic critical values calculated by [20]. One set of critical values is the lower bound critical value (LCB), which assumes that the variables are I(0), while the other set is the upper bound critical value (UCB), which assumes that the variables are I(1). The null hypothesis of no co-integration can be rejected if the F-statistic exceeds the upper critical bound. If the test result is below the lower critical bound, the null hypothesis must not be rejected. If the statistic lies between these two sets of critical values, the outcome remains uncertain.

The next step involves estimating the long-term coefficients b_1, b_2, b_3, b_4, b_5, b_6 and b_7 from the specified equation (2) and determining the optimal orders for the ARDL model based on the Akaike Information Criterion (AIC) or the Schwartz Bayesian Criterion (SBC). The standard error correction model is thus defined as follows deriving the short-run dynamic parameters:

$$\Delta e_t = c_0 + \sum_{i=1}^{m} c_{1i}\,\Delta e_{t-i} + \sum_{i=1}^{m} c_{2i}\,\Delta c_{t-i} + \sum_{i=1}^{m} c_{3i}\,\Delta l_{t-i} + \sum_{i=1}^{m} c_{4i}\,\Delta y_{t-i} + \sum_{i=1}^{m} c_{5i}\,\Delta g_{t-i} + \sum_{i=1}^{m} c_{6i}\,\Delta u_{t-i} + \sum_{i=1}^{m} c_{7i}\,\Delta t_{t-i} + \lambda_i EC_{t-1} + \upsilon_{it} \quad (3)$$

The coefficients c_1, c_2, c_3, c_4, c_5, c_6, and c_7 present the short-run dynamic of adjustment to equilibrium, while the speed of adjustment is denoted by λ, the error correction term is ECt-1, and are the residuals. To investigate the stability characteristics of the model, the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests are applied to the residuals of the error correction equation (3). The CUSUM and CUSUMSQ statistics must remain within the critical bounds at the 5% significance level, indicating that there is insufficient evidence to reject the null hypothesis of stable coefficients in the error correction model.

The data set includes countries of the Eurasian Custom Union, Armenia, Belarus, Kazakhstan, Kyrgyzstan and Russia. The estimated period is 1996–2022 on the annual basis. Dependent variable Education Index is extracted from the Global Data Lab, GDL (2025) [24]. Independent variables electricity consumption per capita, electricity imports and electricity exports are extracted from the International Energy Agency datasets IEA (2024). Other independent variables carbon emissions per capita, GDP per capita, urban population as a share of total population, total population, trade as a share of GDP, government effectiveness was extracted from the World Development indicators database WDI (2024).

Results and discussion

The relationship between various indicators and education in the EAEU member countries was established by the authors through economic analysis. A range of factors such as economic (GDP per capita, trade), social (urban population), environmental (CO2 emissions, electricity consumption) and political (subnational corruption index), were incorporated into the assessment. This comprehensive approach enabled the authors to draw several conclusions based on economic calculations, revealing the interaction between estimated indicators and education in the context of green development in the EAEU region. The findings present an ambiguous picture, highlighting complex dynamics and provide valuable insights into the economic development paths of these countries during their transition deserving further research exploration.

This study estimates equation (1) to analyze annual data over the period 1996–2022 employing the ARDL approach to cointegration. The time series characteristics of the variables in equation (1) are examined using the ADF and PP tests and documented in table 1. Four tests yielded at least one that indicated stationarity in the series. It can be deduced from the employed unit root test results that the series are either stationary or non-stationary, with none of the series exceeding an order of integration of I(1), therefore examined variables are suitable for the ARDL estimations.

Table 1 – Unit Root Tests

Variable: Educational Index				
	Level		First Difference	
	ADF	PP	ADF	PP
Armenia	-0.7381	-0.7381	-5.3001	-5.3042
Belarus	-3.8599	-2.9569	-0.0177	-0.6532
Kazakhstan	-3.125	-2.7228	-1.5797	-1.9959
Kyrgyz Republic	-2.8844	-2.442	-3.0709	-3.0011
Russian Federation	-2.5566	-4.2411	-6.2607	-6.4095
Variable: GDP per Capita				
	Level		First Difference	
	ADF	PP	ADF	PP
Armenia	0.02	0.3	-4.16	-4.01
Belarus	-2.12	-1.82	-2.51	-2.78
Kazakhstan	-1.92	-1.92	-3.4	-3.4
Kyrgyz Republic	-0.66	-0.53	-5.33	-6.38
Russian Federation	-1.67	-1.7	-4.38	-4.38
Variable: CO2 Emissions				
	Level		First Difference	
	ADF	PP	ADF	PP
Armenia	-0.89	-4.58	-0.62	-4.55
Belarus	-1.59	-6.04	-1.6	-5.97
Kazakhstan	-1.6	-4.69	-1.62	-4.69
Kyrgyz Republic	-1.5	-5.13	-1.43	-5.15
Russian Federation	-1.66	-5.78	-1.48	-6.02
Variable: Urban Population				
	Level		First Difference	
	ADF	PP	ADF	PP
Armenia	0.26	-4.8	-0.93	-0.33
Belarus	-2.63	0.05	-2.99	-2.98
Kazakhstan	1.76	3.65	0.34	0.01
Kyrgyz Republic	4.48	3.29	-1.38	-1.94
Russian Federation	5.93	12.38	0.65	1.6
Variable: Trade				
	Level		First Difference	
	ADF	PP	ADF	PP
Armenia	-1.31	-1.22	-4.03	-3.41
Belarus	-5.23	-4.05	-6	-9.31
Kazakhstan	-1.4	-1.39	-5.13	-5.13
Kyrgyz Republic	-1.89	-1.65	-2.51	-2.51
Russian Federation	-1.53	-1.5	-4.31	-6.81
Variable: Subnational Corruption Index				
	Level		First Difference	
	ADF	PP	ADF	PP
Armenia	0.55	-4.61	0.55	-4.61
Belarus	-1.55	-3.89	-1.61	-3.89
Kazakhstan	-2.45	-1.71	-1.06	-4.86
Kyrgyz Republic	1.57	-3.82	1.35	-3.87

Russian Federation	-2.76	-1.92	-1.35	-1.81

Variable: Electric Consumption				
	Level		First Difference	
	ADF	PP	ADF	PP
Armenia	1.45	1.57	-4.52	-4.52
Belarus	-0.09	-0.67	-7.93	-7.79
Kazakhstan	-1.01	-1	-4.76	-4.87
Kyrgyz Republic	-1.03	-1.14	-4.43	-4.44
Russian Federation	-0.67	-0.47	-4.89	-4.86

*Level regressions include intercept and trend, difference regressions contain intercept only
Note: Authors calculation.

To estimate long run coefficients in the model it is necessary to examine if variables are cointegrated and model is stable. Table 2 presents F test statistics for cointegration and short run diagnostics. F-test statistics are in the case of Armenia, Belarus, Kyrgyz Republic and Russian Federation are above the upper bound test providing evidence of cointegration of estimated variables in Eurasian Union countries, except Kazakhstan, where cointegration relations were not found in the estimated model. Error correction terms ECt-1 are negative and significant at the 1% level in all countries, excluding the Kyrgyz Republic. Significant and negative error correction terms confirm the presence of stable long-run relationships among variables across all countries. Cointegration relations in the model are only under question in Kazakhstan and Kyrgyz Republic.

To guarantee that our models meet the stability criterion, we employ the CUSUM and CUSUMSQ tests introduced by [18] to the residuals of the error-correction model specified in equation (3). The results of the stability test CUSUMSQ are summarized in table 2, specifically in the last column. CUSUMSQ statistics typically remain within the critical limits, suggesting stability of the estimated coefficients, although Belarus is an exception.

Table 2 – The F-test results and short run diagnostics

Countries	Bounds test	Error Correction		Shor Run Model		Stability Test
	F-statistic	ECt-1	t-score for ECt-1	LM	Reset	CUSM(2) e
Armenia	6.02a	-0.67	-8.40b	3.12c	0.29	S(S)
Belarus	57.53a	-0.46	-23.74b	0.89	0.16	S(NS)
Kazakhstan	1.85	-0.11	-4.49b	1.28	0.46	S(S)
Kyrgyz Republic	16.37a	0.06	13.86b	1.90	0.81	S(S)
Russian Federation	3.57a	-1.96	-6.05b	5.85c	26.33d	S(S)

* a: The upper bound critical value of F-test for cointegration when there are six exogenous variables at 5% is 3.28.
b: critical t-scores are 2.878, 2.101 and 1.734 at %1, %5 and %10 respectively.
c: LM is the Breusch-Godfrey serial correlation score due to small sample size critical values are obtained from F-distribution.
d: RESET is Ramsey's test for misspecification. It is distributed as Chi-Square with one degree of freedom.
The critical value is 3.84 and 2.70 at 5% and 10% respectively.
e: CUSUM(2) stand for two alternative stability tests. S denotes stability and NS indicates non-stability.
Note: Authors calculation.

The existence of cointegration was established, and equation (3) was then estimated for each selected country using an individual ARDL model specified according to the SBC criterion. The long-run results are depicted in Table 3, with the education index serving as the dependent variable. According to the estimated coefficients, in Kazakhstan and the Kyrgyz Republic, no statistically significant coefficients were found, suggesting that the estimated variables of the model do not have an influence on educational levels in these countries. In the case of Armenia electricity consumption significantly improves education in the long run. It can be related to the infrastructure development that enhances education sector environment. Electricity consumption is related to many benefits for education sector, that take place in Armenia. Increase in electricity consumption is often associated with economic modernization, technological improvements that allow people to access various educational technologies that depend on electricity.

The education index in Belarus is positively and strongly affected by income per capita, that is expected income, however pollution and electricity consumption are found to negatively affect educational level. These two negative coefficients may be related to early stages of development or industrialization, where growing pollution and increasing electricity consumption may damage public services like education, until institutions strengthen.

In case of Russia most of variable were estimated as significant determinants of the education index in the long run, however results are not expected in all cases. Income per capita and government efficiency were found positively significant indicating governance support for education. Similar to Belarus electricity is negatively affecting educational level in Russian Federation due to inefficiencies or high industrial consumption unrelated to education. Growing share of urban population significantly damage educational level that may take place due fast growth of urban population where education infrastructure do not develop as fast. At the same time Russian Federation has high level of migration-driven urbanization where language barriers and relocation may lead to exclusion of children from formal education and lack of parental time for the support. Trade openness support education in Russian Federation leading to better results in the long run.

Table 3 – Long run coefficients results

ARDL approach to cointegration summary long-run results.							
		Estimated Coefficients					
Countries	Constant	Co2	ElCon	GDPpc	SCI	UrPop	Trade
Armenia	6.38	-0.05	0.32	-0.01	0.03	-1.67	0
	(1.42)	(1.19)	(5.19)*	(0.2)	(0.3)	(1.57)	0
Belarus	2.02	-0.35	-0.12	0.35	-0.01	0	-1.01
	(2.38)*	(4.95)*	(2.37)*	(13.07)*	(0.31)	(0.29)	(4.37)
Kazakhstan	13.99	-0.46	0.2	0.32	0.56	-4.53	-0.07
	(0.32)	(0.57)	(0.27)	(0.87)	(0.45)	(0.41)	(0.22)
Kyrgyz Republic	-12.89	-0.08	-0.41	1.06	0.71	0.93	-0.15
	(0.57)	(0.53)	(0.7)	(0.99)	(0.55)	(0.24)	(0.75)
Russian Federation	9.53	0.07	-0.84	0.46	0.11	-3.11	0.09
	(1.22)	(0.61)	(3.24)*	(4.33)*	(1.64)**	(1.74)**	(2.07)*

*, ** and *** indicate 1%, 5% and 10% significance levels respectively. Absolute t values are presented in parenthesis. The order of optimum lags are based on AIC. All variables are in logs.
Note: Authors calculation.

Based on the estimation results, environmental factors have a limited impact on the education index in the countries analyzed. One possible reason for this may be the slow pace of green development, where efforts to improve environmental quality fail to keep up with the accelerating growth in energy consumption. This increases the gap between environmental improvement and environmental degradation. One of the most effective ways to monitor green development is through the ecological

footprint indicator [25]. The table 5 presents a comparative overview of biocapacity and ecological footprint for the Eurasian Custom Union countries over the period 1996 to 2024 measured in global hectares per person. Biocapacity refers to the capacity of ecosystems within a country to regenerate renewable resources and absorb waste, while the ecological footprint measures the population's demand on those natural systems. By examining the relationship between these two indicators, the table reveals each country's level of ecological sustainability or deficit. When a country's ecological footprint exceeds its biocapacity, it is said to be in ecological deficit, relying on natural capital from elsewhere or depleting its own ecosystems. This table provides insights into long-term trends in green development, and the balance (or imbalance) between consumption and ecological capacity.

Table 4 – Biocapacity and ecological footprint for the Eurasian Custom Union countries over the period 1996 to 2024

	Bio RUS	Eco RUS	Bio KAZ	Eco KAZ	Bio ARM	Eco ARM	Bio KYR	Eco KYR	Bio BEL	Eco BEL
1996	6,71	4,92	3,54	4,28	0,54	1,02	1,4	1,12	2,81	4,74
1997	6,86	4,96	3,85	4,12	0,49	1,06	1,43	1,1	2,84	4,86
1998	6,68	4,53	3,4	2,86	0,55	1,1	1,44	1,17	2,7	3,75
1999	6,74	4,83	4,8	2,92	0,55	1,14	1,43	1,14	2,59	3,71
2000	6,82	5,03	4,1	1,83	0,51	1,14	1,43	1,03	2,78	3,91
2001	7,04	5,45	4,53	3,6	0,57	1,23	1,46	0,98	2,81	3,73
2002	7,07	5,04	4,29	3,39	0,62	1,23	1,44	1,01	2,95	3,73
2003	7,04	5,17	4,24	3,53	0,6	1,24	1,44	1,09	3,01	3,9
2004	7,05	5,2	3,83	3,62	0,68	1,41	1,41	1,04	3,19	4,07
2005	7,11	5,24	4,04	4,45	0,72	1,53	1,37	1,1	3,17	4,08
2006	7,15	5,41	4,23	4,69	0,7	1,56	1,34	1,14	3,11	4,29
2007	7,22	5,45	4,47	5,24	0,84	1,9	1,33	1,25	3,24	4,35
2008	7,33	5,53	3,81	5,02	0,83	2,26	1,3	1,47	3,45	4,26
2009	7,26	4,96	4,14	5,19	0,82	1,98	1,35	1,49	3,41	3,87
2010	7,07	5,22	3,53	4,68	0,77	1,97	1,31	1,54	3,29	4,13
2011	7,23	5,73	4,73	6,81	0,85	2,2	1,28	1,62	3,35	3,91
2012	7,03	5,39	3,54	4,88	0,86	2,29	1,21	1,83	3,45	4,41
2013	7,15	5,49	3,91	5,72	0,91	2,21	1,26	1,88	3,28	4,29
2014	7,18	5,28	3,9	4,38	0,93	2,24	1,17	1,82	3,58	4,44
2015	7,13	4,87	3,99	4,16	0,94	2,17	1,28	1,81	3,55	3,85
2016	7,21	4,85	4,12	4,22	0,89	2,07	1,27	1,65	3,38	3,84
2017	7,33	5,07	4,15	4,43	0,8	2,13	1,26	1,71	3,49	4,33
2018	7,19	5,03	4,16	4,12	0,85	2,31	1,24	1,76	3,21	4,33
2019	7,21	5,05	3,77	3,73	0,76	2,35	1,22	1,68	3,32	4,18
2020	7,28	4,8	3,91	4,14	0,81	2,38	1,21	1,48	3,5	3,9
2021	7,25	5,44	3,86	4,25	0,75	2,32	1,09	1,67	3,34	4,06
2022	7,5	6,07	3,82	4,29	0,83	2,63	1,16	1,88	3,33	4,59
2023	7,51	6,11	3,85	4,35	0,83	2,79	1,14	1,83	3,34	4,47
2024	7,54	6,21	3,9	4,48	0,83	2,94	1,12	1,81	3,35	4,48
Note: Compiled from source [25].										

The biocapacity and ecological footprint data from 1996 to 2024 for Russia, Kazakhstan, Armenia, Kyrgyzstan, and Belarus reveal significant differences in sustainability performance across these countries. Russia consistently maintains a strong ecological reserve, with biocapacity levels exceeding ecological footprint throughout the period, although the gap has narrowed in recent years due to

rising consumption. In contrast, Kazakhstan, despite its natural resource base, shows an ecological deficit, particularly after 1997, with a sharp peak in consumption in 2011. Armenia stands out with one of the lowest biocapacity levels and a persistent ecological deficit, highlighting the country's vulnerability and high environmental pressure. Kyrgyzstan, which had a biocapacity surplus in earlier years, transitioned into deficit in the 2010s as its footprint steadily increased. Belarus also remains in ecological deficit, although the gap between biocapacity and footprint has slightly narrowed over time. Overall, the data illustrate varying trajectories in green development, with Russia being the only country among the five to sustain a consistent biocapacity surplus.

Conclusion

This study analyzed long run determinants of the education index in member countries of the Eurasian Custom Union for the 1996–2022 period. Thus, based on the economic analysis conducted on the influence of various determinants on education, the authors arrived at the following conclusion where the obtained economic results from the calculations reveal the following picture. The model estimations in Kazakhstan and Kyrgyz Republic revealed the absence of long run impacts of estimated variables on education index that may be related to policy driven education reforms and not market driven, weakening long run relationships between estimated determinants. The long-run estimation results of this study reveal that key macroeconomic and environmental variables have heterogeneous impacts on education across countries. Electricity consumption shows a significant positive relationship with education in some cases, highlighting the role of infrastructure in supporting learning environments. Conversely, negative or insignificant coefficients for carbon emissions and urban population suggest that environmental degradation and unplanned urban growth can hinder educational outcomes. GDP per capita and government efficiency appear to be important, though their effects vary by country, indicating that economic growth alone is not sufficient without effective governance and targeted educational investment.

Based on these findings, policymakers should prioritize clean and equitable access to energy, improve urban planning to avoid educational service gaps, and ensure that economic growth is accompanied by investments in institutional quality and human capital development. Tailored strategies are essential, as the drivers of educational improvement differ across national contexts.

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БІЛІМ БЕРУ ЖӘНЕ ОНЫҢ ДЕТЕРМИНАНТТАРЫ АРАСЫНДАҒЫ БАЙЛАНЫС: ЕУРАЗИЯЛЫҚ ЭКОНОМИКАЛЫҚ ОДАҒЫНЫҢ ЗЕРТТЕУІ

Аңдатпа

ЕАЭО-ның өңірлік экономикалық интеграцияның халықаралық ұйымы ретіндегі саясаты интеграциялық процестерді тереңдету мен тұрақты Жасыл өсуге қол жеткізу арасындағы ажырамас контекстті айқындайды. ЕАЭО елдерінің Жасыл экономика қағидаттарына бейілділігі олардың 2030 жылға дейінгі Орнықты дамудың ұлттық стратегияларында бекітілген, жасыл дамуды ұлттық ерекшеліктер мен жаһандық сын-тегеуріндерге негізделген стратегиялық басымдық ретінде растайды. Мақала авторлары қоршаған орта сапасының өзгеру көрсеткіштері (жан басына шаққандағы ЖІӨ индексі, carbon emission, urban population, trade индекстері, жан басына шаққандағы энергияны тұтыну деңгейі, мемлекеттік басқару деңгейі) мен білім арасындағы өзара байланысты белгілеуге және негіздеуге бағытталған жаңа шешімдер ретінде ЕАЭО-ға қатысушы елдердің мысалында олардың өзара ықпалына талдау жүргізді. Жаңа нәтижелер ретінде қоршаған орта мен білім беру сапасының өзгеруіне әсер ететін көрсеткіштердің өзара әсері, олардың корреляциясын өлшеу әдістемесін қалыптастыру шеңберінде, кешенді объект – ЕАЭО мысалында көрсетілген. Зерттеу нәтижелері бағаланатын айнымалылардың елдік бөліністегі білімге әсерінің екіұшты көрсеткіштері мен әсерін көрсетті, бірақ Жасыл экономика жағдайындағы жалпы трендтерді анықтауға және жасыл даму контекстіндегі білім берудің елдік мүмкіндіктері мен перспективаларын негіздеуге мүмкіндік берді.

Тірек сөздер: жасыл экономика, білім беру, тұрақты даму, қоршаған ортаның сапасы, Еуразиялық Кедендік одақ, үкіметтің тиімділігі, ластану.

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СВЯЗЬ МЕЖДУ ОБРАЗОВАНИЕМ И ЕГО ДЕТЕРМИНАНТАМИ: ИССЛЕДОВАНИЕ ЕВРАЗИЙСКОГО ЭКОНОМИЧЕСКОГО СОЮЗА

Аннотация

Политика ЕАЭС как международной организации региональной экономической интеграции детерминирует неразрывный контекст между углублением интеграционных процессов и достижением устойчивого

«зеленого» роста. Приверженность стран ЕАЭС принципам «зеленой» экономики закреплена в их Национальных стратегиях устойчивого развития до 2030 г., подтверждает «зеленое» развитие как стратегический приоритет, основанный на национальных особенностях и глобальных вызовах. Авторами статьи в качестве новых решений, направленных на установление и обоснование взаимосвязи между показателями изменения качества окружающей среды (индекс ВВП на душу населения, индексы carbon emission, urban population, trade, уровень потребления энергии на душу населения, уровень государственного управления) и образованием на примере стран – участниц ЕАЭС, проведен анализ их взаимного влияния. В качестве новых результатов показано взаимное влияние показателей, влияющих на изменение качества окружающей среды и образования, в рамках формирования методики измерения их корреляции, на примере комплексного объекта – ЕАЭС. Оценка условий «зеленого» развития стран ЕАЭС проведена за период 1996–2022 гг. Результаты исследования показали неоднозначные показатели и эффекты влияния оцениваемых переменных на образование в страновом разрезе, но позволили выявить общие тренды в условиях зеленой экономики и обосновать страновые возможности и перспективы образования в контексте «зеленого» развития.

Ключевые слова: «зеленая» экономика, образование, устойчивое развитие, качество окружающей среды, Таможенный союз, эффективность правительства, загрязнение.

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