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Ijtimoiy, iqtisodiy, texnologik, ilmiy, ommabop jurnal

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08.00.01 Iqtisodiyot nazariyasi
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08.00.17 Turizm va mehmonxona faoliyati

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MUNDARIJA

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ENVIRONMENTAL DEGRADATION AND CARBON EMISSION: INTERCONNECTED LINKS WITH ECONOMIC GROWTH IN POST-SOVIET

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Abstract. This scientific research examined the relationship between economic growth and carbon emissions in eight economies over the period from 2003 to 2024. The variables consist of GDP per capita, energy consumption, and carbon intensity. The study selected and utilized the Pooled Mean Group Autoregressive Distributed Lag (PMG-ARDL) model, which helped to estimate the relationship in the common, long-run model while heterogeneously accounting for short-run variations across countries. In terms of results, the calculated GDP elasticity per capita revealed an interconnected, complex, and close relationship between the increase in benefits and income and the higher level of emissions ($\beta = 0.6988$, $p < 0.001$). Carbon intensity, the strongest and most influential determinant, revealed the role of production efficiency and economic structure ($\beta = 1.0001$, $p < 0.001$). Furthermore, because emissions do not decrease as population income or profit levels increased, the empirical results did not support the Environmental Kuznets Curve hypothesis. The digits and units in the dynamic analysis section show that the error correction term (–1.0342, $p < 0.001$) relatively faster adjustment compared to long-run growth, although significant heterogeneity across countries is observed. Overall, the results imply that achieving sustainable development in such an economy requires not only relying on economic growth but also improving energy efficiency, technological modernization, and structural transformation.

Key words: CO_2 emissions, GDP per capita, carbon intensity, energy consumption, economic growth, transition economies, PMG-ARDL, Environmental Kuznets Curve.

Annotatsiya. Mazkur ilmiy tadqiqotda 2003–2024-yillarda sakkiz mamlakat iqtisodiyotida iqtisodiy oʻsish va uglerod chiqindilari oʻrtasidagi bogʻliqlik tahlil qilindi. Oʻzgaruvchilar sifatida aholi jon boshiga YAIM, energiya isteʼmoli va uglerod intensivligi tanlab olindi. Tadqiqotda Pooled Mean Group Autoregressive Distributed Lag (PMG-ARDL) modeli qoʻllanilib, u mamlakatlar oʻrtasidagi qisqa muddatli farqlarni heterogen tarzda hisobga olgan holda umumiy uzoq muddatli munosabatni baholash imkonini berdi. Natijalar shuni koʻrsatdiki, aholi jon boshiga YAIM elastikligi daromad va iqtisodiy farovonlikning oshishi bilan emissiyalar darajasining ham ortishi oʻrtasida murakkab va chambarchas bogʻliq munosabat mavjudligini koʻrsatdi ($\beta = 0.6988$, $p < 0.001$). Eng kuchli va taʼsirchan omil sifatida uglerod intensivligi ishlab chiqarish samaradorligi hamda iqtisodiy tuzilmaning muhim rolini namoyon etdi ($\beta = 1.0001$, $p < 0.001$). Bundan tashqari, aholi daromadlari va foyda darajalari oshgan sari emissiyalar kamaymaganligi sababli, empirik natijalar Ekologik Kuznets egri chizigʻi gipotezasini tasdiqlamadi. Dinamik tahlildagi koʻrsatkichlar va birliklar xatolarni tuzatish hadi (–1.0342, $p < 0.001$) uzoq muddatli oʻsishga nisbatan tezroq moslashuvni koʻrsatishini, biroq mamlakatlar oʻrtasida sezilarli heterogenlik mavjudligini namoyon etdi. Umuman olganda, natijalar bunday iqtisodiyotlarda barqaror rivojlanishga erishish uchun faqat iqtisodiy oʻsishga tayanish yetarli emasligini, balki energiya samaradorligini oshirish, texnologik modernizatsiya va tarkibiy transformatsiyani ham amalga oshirish zarurligini koʻrsatadi.

Kalit soʻzlar: CO_2 emissiyalari, aholi jon boshiga YAIM, uglerod intensivligi, energiya isteʼmoli, iqtisodiy oʻsish, oʻtish iqtisodiyotlari, PMG-ARDL, Ekologik Kuznets egri chizigʻi.

Аннотация. В данной научной статье исследована взаимосвязь между экономическим ростом и выбросами углерода в восьми экономиках за период 2003–2024 годов. В качестве переменных использовались ВВП на душу населения, потребление энергии и углеродоёмкость. В исследовании была выбрана и применена модель Pooled Mean Group Autoregressive Distributed Lag (PMG-ARDL), позволившая оценить взаимосвязь в рамках общей долгосрочной модели с учётом неоднородных краткосрочных различий между странами. Полученные результаты показали, что рассчитанная эластичность ВВП на душу населения свидетельствует о сложной, взаимосвязанной и тесной зависимости между ростом доходов и повышением уровня выбросов ($\beta = 0.6988$, $p < 0.001$). Углеродоёмкость, являясь наиболее сильным и значимым фактором, продемонстрировала важную роль производственной эффективности и структуры экономики (β = 1.0001, p < 0.001). Кроме того, поскольку уровень выбросов не снижался по мере роста доходов населения и прибыли, эмпирические результаты не подтвердили гипотезу экологической кривой Кузнеца. Показатели и коэффициенты динамического анализа свидетельствуют о том, что член коррекции ошибок (–1.0342, p < 0.001) обеспечивает относительно более быстрое приспособление по сравнению с долгосрочным ростом, хотя между странами наблюдается значительная неоднородность. В целом результаты показывают, что достижение устойчивого развития в подобных экономиках требует не только опоры на экономический рост, но и повышения энергоэффективности, технологической модернизации и структурной трансформации.

Ключевые слова: выбросы CO_2, ВВП на душу населения, углеродоёмкость, потребление энергии, экономический рост, переходные экономики, PMG-ARDL, экологическая кривая Кузнеца.

INTRODUCTION

Post-Soviet Economic Legacy Following the collapse of the Soviet Union in 1991, the Central Asian countries of Uzbekistan, Kazakhstan, Kyrgyzstan, Tajikistan, and Turkmenistan moved from centrally planned economies to market-oriented economies (World Bank, 2023). Under the Soviet-era, the state accounts for the distribution of energy and resources and for establishing institutional and structural patterns that remain to affect economic development (Zhakiyev et al., 2025; RDPB, 2021; Organization for Economic Cooperation and Development, 2020). Although the economic activity was stimulated by liberalization and privatisation, the pace and depth of reforms differed among countries due to differences in resources and institutional capacity (OECD, 2020). Consequently, the region has adopted diverse economic trajectories, brought about by the quality of governance and institutional structures. At the same time, a significant part of the industrial infrastructure and energy networks inherited from the Soviet period still predominates in the region (Zhakiyev et al., 2025; De Keyser et al, 2025).

Furthermore, these architectural legacies have affects for the environment, notably in terms of carbon intensity and also emission factors (International Energy Agency, 2022). Structure of Energy and Resource Dependence Energy resources are at the core of the economic development of a number of Central Asian countries. It is especially relevant to include the states mentioned here among such nations. Kazakhstan, Turkmenistan and Uzbekistan have significant mineral potentials, and exports of their energy resources are one of the main sources of fiscal revenues and economic growth (Imran et al., 2025; Zhakiyev et al., 2025).

On the other hand, Kyrgyzstan and Tajikistan, which are less endowed in terms of minerals, have developed stronger reliance on sectors such as hydropower, remittances, and agriculture, creating opportunities for diversified economic development and renewable energy utilization (De Keyser et al., 2025). In many resource-rich economies, the availability of natural resources has supported the expansion of industrial activity and energy-intensive sectors, contributing to rapid economic growth and industrial integration (OECD, 2020). Industrial Infrastructure and Environmental Efficiency Many industrial sectors in Central Asia continue to benefit from the extensive industrial infrastructure inherited from the Soviet era (Zhakiyev et al., 2025). Ongoing modernization efforts and gradual improvements in production processes are creating additional opportunities to enhance energy efficiency and reduce CO2 emissions over time (International Energy Agency, 2022). Growth Emissions Relationship Economic expansion is generally associated with increasing energy demand as production and industrial activities continue to expand, contributing to higher levels of CO2 emissions (Imran et al. 2025; Zhakiyev et al., 2025). However, the intensity of this relationship varies according to structural and institutional factors. Carbon intensity (emissions per unit of GDP) serves as an important indicator of environmental efficiency; when carbon intensity declines, economic growth becomes more sustainable, reflecting progress toward environmentally efficient development pathways (OECD, 2020).

This study aims at investigating the connection between economic growth and environmental degradation in selected countries. Central Asia is still relatively understudied with regard to environmental economics, especially for panels, which reflect short-term and long-run equilibrium. Challenging an important regional gap in the literature, this research focuses on five post-Soviet economies. The study also adds to the wider debate about whether the economics of growth necessarily drive environmental degradation or whether it is possible to structurally transform economies and improve efficiency to separate growth from emissions. The findings contain policy-related information for decisionmakers concerning the balance governments need to make between economic development and climate commitments within international agreements such as the Paris Agreement. Empirically, the study tests the impact of GDP per capita on CO2 emissions, the role of energy consumption in the increase of emissions and the importance of carbon intensity as a sign of environmental efficiency. The framework is the PMG -ARDL to separate short-run from long-run dynamics on the hypothesis of the Environmental Kuznets Curve to test cross-country differences in institutional structure and energy resource and industrial legacy.

REVIEW OF LITERATURE ON THE SUBJECT

The interaction between economic development and environmental sustainability is one of the central themes in the current environmental economics debate. While accelerated economic growth increases income, industrial output and living standards, it concomitantly increases energy demand and exploits natural resources. As a result, levels of carbon dioxide invariably rise in line with growing economies. The empirical investigations often show a positive strong correlation between economic growth, higher as energy consumption and emissions (especially fossil-fuel-based economies) (Androniceanu and Georgescu 2023; Apergis and Payne 2020). However, the extent of this relationship is different in each national context. The outcomes for the environment depend on a country's economic structure, main sources of energy, technological capacity, institutional strength, and regulatory frameworks towards environmental concerns (Haloui, 2025; Otim et al., 2025). Thus, growth did not necessarily lead to environmental degradation, and the configuration and the governance of the economy acted as a mediator between the environmental impact.

The Environmental Kuznets Curve (EKC) hypothesis is based on the view that there is an inverted-U shape curve between per capita income and environmental degradation (the two are inversely correlated). In the early stages of development, there is often a surge in the amount of emissions because there are no laws to curb industrial expansion. Beyond a threshold income level, countries have the ability to reduce emissions through cleaner technology in production, tougher environmental policies and economic realignments (Kaplan, 2025). At the same time, there is a heterogeneity of empirical evidence. In many developing and transition economies, poor diversification and low institutional capacity challenges environmental amelioration, and the challenge of not understanding that more income per se will not necessarily lead to less emissions.

The Energy- Growth Nexus brings energy into the limelight as key input in economic production. As economies grow, the demand for energy increases, adding to emissions (Apergis & Payne, 2020). A massive literature is available to support the premise that energy consumption is directly related to CO2 emissions and may be the pathway over which gross domestic product affects environment results (Androniceanu & Georgescu, 2023; Haloui, 2025). For countries with abundant natural resources, a reliance on fossil fuels increases pressure on the environment. On the other hand, higher use of renewable energy would reduce emissions and limit the environmental cost of increased growth. Empirical studies conducted in Uzbekistan show that fossil energy consumption plays an important role in contribution to CO2 emissions. Contemporary scholarship therefore pays much closer attention to efficiency, especially carbon intensity. The Kaya Identity outlines emissions in terms of income, energy utilisation and carbon intensity (Yakymchuk et al., 2025). Carbon intensity - defined as CO2 produced divided by a unit of economic output - is one indicator of the progress in efficiency and providing cleaner technologies. Research suggests technology across the technology and renewable energy development and digital transformation can curb carbon intensity measurement (Duan & Duan, 2024; Liu et al., 2025). However, in economies whose industrial systems are obsolete the carbon intensity may be high despite increasing income levels. Nations that are heavily dependent on the extraction of fossil fuels often develop economic structures that are carbon intensive (Kuziboev et al., 2024).

Although the body of literature worldwide that relates economic growth to emissions is vast, there still remains a glaring lack of studies in which the focus is specifically on Central Asia. Predominantly, scholars tend to rely on univariate time series analytics such as ARDL whereas few exploited the use of dynamic panel methods which can mean disentangling short run from long run dynamics and long run equilibria (Kaplan, 2025). Consequently, there is a substantive lacuna in relation to the effect of GDP per capita, energy use and carbon intensity on emissions in Central Asian economies. By using a framework based on a panel modelled generalized differencing ARDL (PMG-ARDL), this study attempts to specify the dynamics of emissions over the short run and the long run, and determine whether economic growth in the region is carbon intensive, or is a result of an increase in environmental efficiency.

H1. Economic growth (GDP per capita) increases CO_2 emissions in Central Asian countries.

H2. Higher energy consumption leads to higher CO_2 emissions.

H3. Lower carbon intensity (better efficiency) reduces CO_2 emissions (Figure 1).

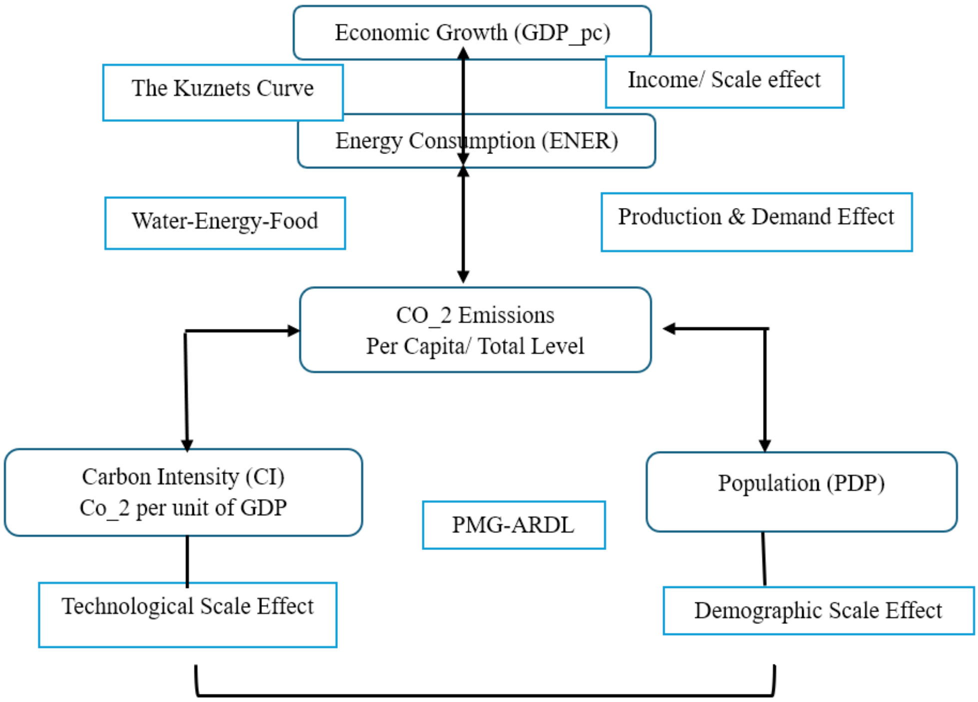

Figure 1. Theoretical Framework of the study[1]

RESEARCH METHODOLOGY

This research has taken a quantitative dynamic panel framework using the Pooled Mean Group Autoregressive Distributed Lag (PMG-ARDL) methodology. The model is based on synthesizing three basic theoretical constructs: (1) Environmental Kuznets Curve (EKC) that assumes a non-linear relationship between income and emissions (Kaplan, 2025); (2) Energy-Growth Nexus that highlights energy as an integral component of productivity that links economic growth with environmental pressure (Apergis & Payne, 2020); and (3) Kaya Identity which disaggregates emissions into population, income, energy intensity, and carbon intensity shares (Yakymchuk et al., 2025).

The empirical data set is based on balanced annual panel observations for eight post-Soviet states - Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, Turkmenistan, Armenia, Azerbaijan and Georgia - over the period 2003-2024, with 176country-year observations. CO2 emission values are taken from the EDGAR and Global Carbon Budget repositories while macro-economic and energy statistics are taken from the World Bank's World Development Indicators (WDI) and International Energy Agency (IEA). All continuous variables undergo natural - logarithmic transformation to stabilize variance, control heteroskedasticity and make coefficients interpretable as elasticities (Table 1).

Table 1. Variables and Sources[2]

Variable	Code	Source
Country	COUNTRY	Identifier: country name (panel ID).
Year	YEAR	Identifier: calendar year.
GDP per capita (PPP, 2017)	GDP_pc	WDI; USD (PPP, 2017); ln for lnGDP.
CO2 per capita	CO2_pc	WDI; tonnes per person; ln for lnCO2.
Total CO2	CO2_tot	WDI; Mt (level).
Energy per capita	ENER	WDI; kg oil eq.; ln for lnENER.
Carbon intensity	CI	Computed; CO2/GDP; ln for lnCI.
Population	POP	WDI: million persons (level).
Renewables share	RENEW	WDI; % of energy mix (level).
Natural logarithm of all continuous variables	ln+VARNAME	Computed by Python

1 Source: developed by the author
2 Source: developed by the author

The baseline long run specification has the dependent variable as per capita CO2 emissions, including the variable GDP per capita and its squared form to account for nonlinear EKC dynamics.

$$\ln(CO_{2it}) = \alpha + \beta_1\ln(GDP_{it}) + \beta_2[\ln(GDP_{it})]^2 + \beta_3\ln(ENER_{it}) + \beta_4\ln(CI_{it}) + \mu_i + \lambda_t + \varepsilon_{it}$$

In this setting, the coefficient, beta one, is the marginal revenue effect, beta two is the EKC hypothesis test (negative coefficient pointing to an upside-down U shape), beta three is the elasticity of energy consumption, and finally beta four is the effects of carbon efficiency. When the values of beta one greater than zero and beta two less than zero, EKC hypothesis is said to be corroborated and so value of the turning point is computed.

$$GDP* = \exp(-\beta_1/2\beta_2).$$

The PMG ARDL estimator allows for heterogeneity between countries in terms of short run coefficients and speed of adjustment, but imposes homogeneity in terms of the long run coefficients.

$$\Delta\ln(CO_{2it}) = \varphi_i(\ln(CO_{2i,t-1}) - \theta'X_{it}) + \Sigma\delta_{ij}\,\Delta\ln(CO_{2i,t-j}) + \Sigma\psi_{ij}\,\Delta X_{i,t-j} + \varepsilon_{it}$$

The error-correction formulation has the addition of the country-specific speed of adjustment term, which is denoted as a phi subscript i; a statistically significant negative phi subscript i points to correction to long-run equilibrium. The use of the PMG approach is considered suitable where theoretical arguments are that similar long run relationships may exist across nations despite heterogeneity in the short run (Apergis & Payne, 2020).

ANALYSIS AND RESULTS

Selected statistical description for the primary variables is given in Table 2. The average total amount of CO2 emissions is 26.7 million tons, but there is a huge range of emission (standard deviation = 38.3 million tons), which is due to significant heterogeneity in the size and economic structure of countries. Kazakhstan has the highest average emissions (254 million tons) thanks to its very large area and its fossil fuel-based economy, while Armenia has the lowest average emissions (5 million tons) due to its smaller population and its cleaner energy mix. GDP per capita shows an average of $14,800 (in 2017 PPP dollars) and the coefficient of variation is 30 per cent, which reveals moderate income inequality across the region. Energy consumption per capita is much less variable (CV of 23%), indicating more equal access to energy despite differences in income. Population varies between 3.0 million (Armenia) and 30.7 million (Uzbekistan) which require population controls in the aggregate emissions model (Table 2).

Table 2. Descriptive Statistics[3]

Variable	Mean	Std. Dev.	Min	Max	CV (%)
CO_2 total (MT)	26.7	38.3	1.5	270.1	143.4
GDP pc ($1000)	14.8	4.5	4.3	40.3	30.4
Energy pc (kg oil eq.)	2048	472	1083	4961	23.0
Population (million)	11.4	10.3	3.0	42.3	90.4

Table 3 compares Variance Inflation Factors before and after performing the process of centering. In the first specification, the VIF values of GDP and GDP2 are 0.692, which shows that there is near perfect multicollinearity making the estimation of coefficients extremely unstable. Energy consumption and carbon intensity also have high VIF values (37 and 33, respectively), but less so than the GDP variables. After centering GDP before squaring, the VIF of the GDP squared (VIF of the first term) drops to 1.01, which essentially rules out the existence of multicollinearity between the linear and the quadratic term. The VIF on centered GDP is still moderate at 1.63. Energy consumption and population show acceptable values of VIF (2.92 and 2.18), that is well below the critical threshold. This affirms the success of centering in order to overcome the multicollinearity issue, without losing the ability to test the Environmental Kuznets Curve (EKC) hypothesis (Table 3; 4).

3 Note: N=176 observations (8 countries × 22 years). CV = coefficient of variation (std.dev./mean × 100).
Source: developed by the author

Table 3. Variance Inflation Factors[4] (Before and After Centering)

Variable	VIF (Original)	VIF (Centered)
GDP / GDP_c	698.96	1.63
GDP² / GDP_c²	699.00	1.01
Energy pc	36.94	2.92
Population	—	2.18

Table 4. Main model[5]

Variable/Statistic	Pooled OLS (Total CO_2)	Fixed Effects (Total CO_2)	Random Eff. (approx)	PMG-ARDL (per capita)	Pooled OLS (per capita)
MAIN COEFFICIENTS					
Constant	-12.97*** (1.92)	-9.03*** (0.17)	—	-6.91*** (0.00)	-13.24*** (1.93)
GDP / GDP_c	0.893** (0.398)	0.047*** (0.006)		0.9988*** (0.0004)	0.909** (0.400)
GDP² / GDP_c²	-0.040* (0.021)	-0.082*** (0.005)		+0.0001*** (0.0000)	-0.041** (0.021)
ln(ENER_pc)	1.261*** (0.028)	1.400*** (0.024)		-0.0002 (0.0004)	1.299*** (0.019)
ln(POP)	1.019*** (0.010)	0.845*** (0.022)	—		
ln(CI)	—	1.0001*** (0.0003)	—		
ECT(-1)		-1.034*** (0.083)			
MODEL FIT STATISTICS					
R²	0.6962	0.6998	—	1.0000	0.9757
Adjusted R²	0.6961	0.6998		1.0000	0.9753
RMSE	0.0868	0.0180		0.0001	0.0874
AIC	-497.4	-878.2		-2648	-350.3
BIC	-481.2	-834.5		-2613	-337.6
F-statistic	11,120***	94,558***		—	1,721***
SPECIFICATION TESTS					
F-test (FE vs Pooled)	—	545.74***	—		
Hausman (FE vs RE)		Use FE	Rejected	—	
EKC Hypothesis	weak	(β_2<0***)	—	REJECTED (β_2>0***)	weak
MODEL SELECTION	base	accepted		Problem with indetity	compare

The Pooled OLS model of total CO2 emissions does not control for country-specific characteristics and thus all countries are in a single cohort. The results show that the variables GDP clear has a positive and statistically significant effect (0.893) to the variable emissions which indicates that economic growth tends to increase carbon emissions. This finding is consistent with many empirical studies which document how economic expansion tend to increase pressure on the environment, especially in developing and transition economies (Stern, 2004; Dinda, 2004). The value of the GDP2 coefficient is negative (-0.040) showing low evidence for the EKC hypothesis. Energy consumption (ln ENER_pc = 1.261), population (ln POP = 1.019) also have significant positive impacts on emissions consistent with the results of other studies that found energy demand and demographic increases as key factors in environmental pressure (Apergis and Payne 2009). More importantly, the coefficient of the GDP² variable is negative and highly significant (-0.082), confirming the EKC hypothesis in this framework. The Fixed- Effects model provides the best fit in terms of statistical tests and model performance criteria. The findings imply that there is a continued close association between economic growth and carbon-intensive energy use in post-Soviet countries (Stern, 2004).

Panel unit root testing using the IPS approximation shows that each variable is non-stationary in levels indicating the unit roots are present. Cross-sectional dependence tests confirm high interdependence between countries with all Pesaran CD statistics being significant at p<0.001, implying that there are common shocks

4 Note: VIF>10 indicates severe multicollinearity, VIF>5 indicates moderate concern, VIF<5 is acceptable. Centering successfully reduces multicollinearity to acceptable levels. Source: developed by the author

5 Source: developed by the author

in the region. The Pesaran CD test statistics vary between 11.46 (lnENER) and 23.59 (lnCI); and average cross country correlations range between 0.46 and 0.95. A Kao residual based cointegration test provides an augmented Dickey Fuller (ADF) statistic of -4.619, however, attention should be paid while interpreting the statistical significance due to poor temporal dimension.

Table 5 reports country specific short run coefficients and a large heterogeneity in adjustment dynamics across the sample countries. The error correction term (ECT) measures the velocity of the return of each country to long run equilibrium after a short run shock. Uzbekistan shows the most rapid adjustment (ECT= -1.597), followed by Azerbaijan (-1.194) and Kazakhstan (-1.131). By contrast, Georgia shows the fastest adjustment (ECT = -0.598), possibly reflecting its relatively low level of carbon intensity and the large contribution of hydropower to the electricity generation. Other countries are one step lower on the scale - Serbia (-0.809) and Ukraine (-0.804) - with moderate speeds of adjustment: the length of correction process is longer. Across countries, the short run DlnGDP coefficients are close to one, indicating the existence of a strong and consistent short run relationship between growth and carbon emissions (Table 5).

Table 5. Country-Specific Short-Run Coefficients[6]

Country	ECT(-1)	ΔlnGDP	ΔlnENER	ΔlnCI
Kazakhstan	-1.1306	1.0013	-0.0014	1.0003
Uzbekistan	-1.5966	0.9964	0.0051	0.9981
Azerbaijan	-1.1940	0.9970	0.0038	0.9967
Armenia	-0.9596	0.9969	0.0064	0.9964
Georgia	-0.5976	1.0036	-0.0070	1.0016
Serbia	-0.8088	1.0022	-0.0047	1.0008
Ukraine	-0.8045	1.0008	-0.0009	1.0006
Moldova	-1.0825	1.0012	-0.0029	1.0004

To try to validate the robustness of the results the model was re-estimated with the renewable-energy share (RENEW) fostered in as an additional control variable. The results of robustness analysis confirm the key results: the coefficient of GDP is still positive and significant ($b=0.9989$, $p<0.001$); carbon intensity is the overwhelming main driving factor ($b=0.9999$, $p<0.001$); the square root of GDP is positive ($b=0.0001$, $p<0.001$). The share of renewable energy gives a negative but statistically insignificant contact ($b = -0.00004$, $p = 0.592$), indicating that the current share of renewable energy penetration is not high enough to offset the growth of emissions in the region in a material way.

CONCLUSIONS AND SUGGESTIONS

The current study focused on the relationship between economic growth and CO emissions for eight Post-Soviet countries during 2003-2024. The results clearly demonstrate that economic expansion has been accompanied by increased industrial and production activity, reflecting the dynamic growth processes within these economies. The relationship is strong and, in many cases, closely proportional, highlighting the important role of industrial development and energy use in supporting economic progress. The EKC hypothesis was not fully confirmed, indicating that emissions remain closely connected with economic growth across the examined countries. This pattern suggests that further improvements in environmental sustainability can be achieved through structural transformation and technological modernization. A major insight relates to carbon intensity, which emerged as a key determinant of emissions. This highlights the growing importance not only of production volume, but also of production quality and efficiency.

Many sectors continue to benefit from existing industrial and energy infrastructure, while ongoing modernization processes create opportunities to improve energy efficiency and environmental performance. Energy consumption, although not a major long-run variable when holding other variables constant, remains an important factor, particularly regarding the composition and quality of energy sources used. Cleaner energy sources demonstrate strong potential for reducing emissions while maintaining stable levels of energy use. Overall, the findings indicate that sustainable economic growth can be further strengthened through gradual structural modernization, cleaner technologies, and improved energy efficiency policies.

6 Source: developed by the author

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