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Impact of Institutions and Human Capital on CO_2 Emissions in EU Transition Economies

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Abstract: Environmental degradation is one of the most significant problems of the globalized world. This paper explores the impact of institutional development and human capital on CO_2 emissions in 11 EU transition economies over the period of 2000–2018 through co-integration analysis. The co-integration analysis revealed that human capital negatively affected CO_2 emissions in Croatia, the Czech Republic, Hungary, and Slovenia, and that institutions had a negative impact on CO_2 emissions in the Czech Republic. However, both institutions and human capital positively affected CO_2 emissions in Latvia and Lithuania.

Keywords: institutional development; human capital; CO_2 emissions; co-integration analysis

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1. Introduction

The significant increase in industrialization, mass production, global population, and urbanization has deteriorated the environment over the past two centuries and has led to many environmental problems, including climate change, water, air, and soil pollution and degradation, waste-utilization problems, species extinction, and deforestation. Environmental degradation has become one of the most serious problems faced by human beings in terms of health and sustainable economic growth and development. Therefore, national (especially developed economies) and international authorities began to introduce measures for environmental sustainability. The 1972 United Nations Conference on the Environment was the first global organization to bring attention to environmental problems [1]. As a result, the United Nations Environment Program (UNEP), governed by the United Nations Environment Assembly as a global body, was established in 1972 to set environmental agendas and organize environmental policies on a global scale [2]. Furthermore, the Intergovernmental Panel on Climate Change (IPCC), which is the United Nations' body for climate change, was formed by the United Nations Environment Program (UN Environment) and the World Meteorological Organization (WMO) in 1988 [3].

The European Union (EU) has also struggled to bring attention to environmental sustainability since the first UN conference on the environment. The Single European Act of 1987 introduced the term "environment," which was the first legal basis for common environmental policies aimed at the preservation of environmental quality, human health, and the rational employment of human resources [4]. The EU environmental policy has been implemented by the Environment Action Program (EAPs) since the 1970s, and a 55% reduction in greenhouse-gas emissions to 1990 levels by 2030 is a target of the 2030 Climate Target Plan [5]. On the other hand, China, which has the largest energy consumption and CO_2 emissions, targets to maintain its international competitiveness and sustainable development through a national carbon-trading system [6].

Globally, environmental quality has significantly degraded, prompting scholars to explore the factors underlying environmental degradation and possible environmental measures to restore the environment. In this context, economic growth, industrialization, urbanization, population, residential heating systems, energy consumption, industrialization, deforestation, trade openness, FDI inflows, and globalization have been documented as the main causes of environmental degradation in the related literature [7–19]. Furthermore, an extensive number of studies in the related literature have tested the validity of the Environmental Kuznets Curve (EKC) hypothesis, which suggests the interaction between environmental and economic development levels for different countries, and have reached mixed findings [20–23].

Legislative environmental measures such as environmental regulations and standards, as well as market-based environmental policy instruments such as environment tax, transferable emissions permit, and government subsidy reductions have been developed in order to mitigate and restore earth systems from environmental degradation [24]. Furthermore, renewable energy and efficiency through new and cleaner technologies have been observed to significantly mitigate environmental degradation [25–27].

Both institutions and human capital are significant players in the implementation of the appropriate and prudent environmental policies. In this context, the role of institutions and their effect on the environment is shown in the literature in many direct and indirect examples. It is extremely likely that strong and efficient institutions can maintain environmental quality by ensuring the efficient functioning of local and global environmental regulations, rather than being perceived to encourage corruption and the shadow economy [28]. Institutional quality may negatively affect the environment by fostering economic growth [29]; however, increasing overall income can raise the environmental awareness of the population [28]. We suggest that the net effect of institutions can change depending on which factors are dominant. Alternatively, human beings have been shown to have a significant impact on the global environment through their consumption and production activities. Therefore, we suggest that local populations with higher environmental awareness through education and training can have a positive impact on environmental quality, but human capital is also a significant determinant of economic growth. Similarly, the net effect of human capital on the environment can change depending on which channels are dominant.

The determinants of environmental degradation or CO_2 emissions have been extensively explored, while the environmental effects of both institutions and human capital have been relatively less explored, as can be seen from the empirical literature review. Therefore, in this study, we focus on institutions and human development in a sample of EU transition economies that are experiencing structural change in institutions and human capital with the contribution of transition and EU membership processes. The scores of institutions and human capital of the EU transition economies are presented in Table 1. Table 1 shows that Czechia, Latvia, and Lithuania made significant improvements to their institutions, whereas only Hungary experienced deteriorations in its institutions. On the other hand, Bulgaria, Czechia, Estonia, Poland, Slovakia, and Slovenia experienced considerable progress in human capital, but the other countries experienced relatively fewer improvements to human capital.

Table 1. Development of institutions and human capital in EU transition members.

Countries	Year	Institutions Score	Human-Capital Score
Bulgaria	2000	57.8042	51.68337
Bulgaria	2018	59.52434	58.98156
Croatia	2000	58.9135	55.54833
Croatia	2018	64.41148	58.57758
Czechia	2000	67.81401	56.78816
Czechia	2018	76.75671	67.39377
Estonia	2000	75.44497	54.6999
Estonia	2018	82.69684	64.02946
Hungary	2000	77.0254	55.07496
Hungary	2018	64.25326	61.61617
Latvia	2000	63.85738	53.05329
Latvia	2018	73.83265	55.76249
Lithuania	2000	65.66885	55.9387
Lithuania	2018	77.38173	59.91948
Poland	2000	70.91636	54.6009
Poland	2018	72.25084	61.12796
Romania	2000	44.02271	47.67062
Romania	2018	51.5108	52.06732
Slovakia	2000	67.19018	53.83563
Slovakia	2018	72.15298	60.84067
Slovenia	2000	75.2741	61.48158
Slovenia	2018	76.24501	71.8252

Source: UNCTAD [30].

We aim to make a contribution to the empirical literature in three ways. In the related empirical literature, scholars have generally proxied the institutions by worldwide governance indicators of the World Bank. Therefore, the first contribution of the study is to use the institutions index by UNCTAD (United Nations Conference on Trade and Development) in view of the related literature. Secondly, this study is targeted to be one of the first to analyze the interaction among institutions, human capital and CO_2 emissions in a sample of EU transition economies. Thirdly, the employment of a second generation co-integration test, which also produces robust findings for small samples, was evaluated in order to raise the reliability of the findings. The general framework of our research is as follows: The theoretical and empirical literature summary is presented in Section 2, then the data and methods are described, the results and discussion are given in Section 4, and finishes with the conclusions.

2. Empirical Literature Review

The environmental degradation has become a critical problem for the globalized world. Therefore, institutional and economic determinants of environmental degradation have been extensively explored in the related literature. The related literature has documented institutional quality, human capital, economic growth, population, energy consumption, industrialization, urbanization, export, FDI inflows, trade, and financial openness [7–19].

In this study, we focused on the impact of institutions and human capital on the environmental quality proxied by CO_2 emissions by considering the limited literature and the significant role of institutions and human capital in the design and implementation of environmental policies. In the empirical literature, most scholars have determined that a higher institutional quality has raised the environmental quality, as can be seen from the following empirical literature review.

Tamazian and Rao [31] explored the impact of institutional quality on environmental quality in transition economies over 1993–2004 through dynamic regression analysis and revealed that strong institutions was a significant determinant of environmental quality. On the other hand, Lau et al. [32] also explored the effect of institutions on CO_2 emissions in

Malaysia over 1984–2008 through the ARDL co-integration test and determined a decreasing effect of institutions on CO_2 emissions.

Gill et al. [33] explored the effect of public governance on CO_2 emissions in South-Eastern Asian countries over 1980–2014 and revealed the worldwide governance indicators as the significant determinants of CO_2 emissions. On the other hand, Baloch and Wang [34] explored the effect of governance on CO_2 emissions in BRICS economies over 1996–2017 through the Westerlund co-integration test and determined that a higher governance level decreased the CO_2 emissions. Ali et al. [35] also explored the impact of institutions proxied by a variable derived from corruption, rule of law, and bureaucratic quality of the International Country Risk Guide on CO_2 emissions in 47 developing countries through dynamic regression analysis and determined a negative effect of institutional quality on CO_2 emissions.

Ahmed et al. [36] explored the effect of institutional quality proxied by an index calculated from worldwide governance indicators and some economic variables on the environment in Pakistan over 1996–2018 through the ARDL co-integration approach and determined the ultimately negative impact of institutional quality on CO_2 emissions. Nkengfack et al. [37] also explored the impact of public governance proxied by worldwide governance indicators on environmental quality in the Economic Community of Central African States over 1996–2014 and found that public governance had a positive effect on the environmental quality.

Simionescu et al. [38] analyzed the effect of worldwide governance indicators on GHG emissions in Central and Eastern European states over 2006–2019 through estimators of panel dynamic OLS and panel autoregressive distributed lag and determined that public governance indicators decreased GHG emissions. On the other hand, Wu and Madni [28] researched the institutional development proxied by an index formed from 12 institutional indicators from the International Country Risk Guide on the environmental quality in One Belt, One Road countries over 1986–2017 through a panel threshold regression analysis and discovered that institutional quality decreased the environmental degradation after a threshold level of institutional quality.

Sah [39] explored the impact of institutional development proxied by an index derived from worldwide governance indicators on CO_2 emissions in the Economic and Monetary Community of Central African countries over 1996–2017 through a first generation co-integration analysis and discovered a negative impact of institutional development on CO_2 emissions.

These few studies have determined a positive impact of institutional development on CO_2 emissions in the empirical literature on environmental institutions. Cole [40] explored the impact of corruption on CO_2 and sulfur dioxide emissions in 94 countries over 1987–2000 and revealed the increasing impact of corruption on both emissions. Goel et al. [41] explored the impact of institutional quality proxied by corruption and the shadow economy in a panel consisting of over 100 countries over 2004–2007 and revealed that countries with more corruption and shadow economy experienced lower emissions, but higher emissions in MENA countries. Nguyen et al. [29] explored the impact of institutions on CO_2 emissions in 36 emerging countries over 2002–2015 through dynamic regression analysis and determined a positive impact of institutional development on CO_2 emissions.

The empirical literature on the impact of human capital on the environment has mainly revealed a positive impact of human capital on environmental quality. In this context, Bano et al. [42] explored the effect of human capital on CO_2 emissions in Pakistan over 1971–2014 through ARDL co-integration and revealed the ultimately decreased effect of human-capital improvement on CO_2 emissions. Mahmood et al. [43] also researched the effect of human capital on CO_2 emissions in Pakistan over 1980–2014 through regression analysis and discovered a negative effect of human capital on CO_2 emissions. On the other hand, Li and Ouyang [44] analyzed the effect of human development and some economic variables on CO_2 emissions in China over 1978–2015 through ARDL co-integration and revealed an inverted N-shaped interaction between human capital and CO_2 emissions, which suggested that human-capital improvement decreased CO_2 emission intensity and raised emissions in the short term while decreasing them in the long term.

Yao et al. [45] explored the effect of human capital on CO_2 emissions in 20 OECD economies over 1870–2014 and determined that human-capital development decreased the CO_2 emissions in the long run, but the non-parametric estimations revealed that the interaction between human capital and CO_2 emissions became negative in the 1950s and then the negative impact became stronger.

Zhang et al. [46] explored the effect of human capital on CO_2 emissions in Pakistan over 1985–2018 by employing dynamic ARDL co-integration and discovered that human capital decreased the CO_2 emissions in the long term, but raised them in the short term. Wang and Xu [47] also explored the effect of human capital together with internet usage on CO_2 emissions in 70 economies over 1995–2018 through regression analysis and found that human capital was a significant determinant of economic development with a low carbon footprint.

Lin et al. [48] explored the effect of innovative human capital on CO_2 emissions in 30 Chinese provinces over 2003–2007 through static and dynamic regression analyses and determined a decreasing effect of human capital on CO_2 emissions. Joof and Isiksal [49] explored the effect of human capital on CO_2 emissions in Mexico, Indonesia, Nigeria, and Turkey over 1975–2010 through a pooled mean group estimator and determined a negative effect of human capital on CO_2 emissions. Xiao and You [50] analyzed the effect of human capital on green total factor productivity in 30 Chinese provinces over 2001–2018 through regression analysis and revealed a positive effect of human capital on green total factor productivity.

3. Data and Method

This study explored the impact of institutions and human capital on CO_2 emissions in EU transition members over 2000–2018 through co-integration analysis. In the empirical analysis, carbon dioxide emissions were proxied by carbon dioxide emissions (metric tons per capita). On the other hand, institutions and human capital were represented by scores of institutions and human capital between 0 and 100 (higher values mean better institutions and human capital) of UNCTAD [51]. The institutions score was calculated by considering political stability, regulatory quality, effectiveness, success in fighting corruption, criminality and terrorism, and freedom of expression and association [30]. The human-capital score reflected the education, skills and health conditions of each country's population, their research and development integration and their gender dimension [51]. The data of CO_2 emissions was obtained from the World Bank database [52], and the institution and human-capital scores were provided from the UNCTAD [30] database. All series are annual and the study covered 2000–2018 (see Table 2). The logarithmic forms of the variables were used in the econometric analyses.

Table 2. Dataset definition.

Variable	Abbreviation	Data Source
Carbon dioxide emissions (metric tons per capita)	*CO*	World Bank [52]
Institutions index	*INST*	UNCTAD [30]
Human-capital index	*HUMAN*	UNCTAD [30]

The following econometric model was formed in order to explore the impact of institutions and human capital on CO_2 emissions in a country i ($i = 1, \ldots, 11$), in year t ($t = 2000, \ldots, 2018$).

$$CO_{it} = f(INST_{it}, HUMAN_{it}) \quad (1)$$

The EU transition economies consist of Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia. The key characteristics of the series are displayed in Table 3. The average CO_2 emissions in terms of metric tons per capita were about 6.5762 and the average institutions and human-capital scores were, respectively, 69.3187 and 58.8173. However, the quality of institutions and human capital significantly changed from country to country as seen in Table 3.

Table 3. Descriptive statistics of the dataset.

	Characteristics	*CO*	*INST*	*HUMAN*
Countries	Mean	6.5762	69.3187	58.8173
	Maximum	14.8059	82.9772	74.7581
	Minimum	2.9270	44.0227	47.6706
	Std. Dev.	2.8798	8.4476	5.1028
Bulgaria	Mean	6.0796	59.5356	55.1254
	Maximum	6.9738	60.9912	59.4539
	Minimum	5.3034	57.8042	51.6833
	Std. Dev.	0.4353	0.92939	2.58111
Croatia	Mean	4.4981	63.6732	57.0224
	Maximum	5.3106	65.4378	58.6673
	Minimum	3.8552	58.9135	54.91431
	Std. Dev.	0.4576	1.66797	1.305984
Czechia	Mean	10.8933	74.9831	63.1774
	Maximum	12.1054	76.7895	68.5973
	Minimum	9.4771	67.8140	56.7881
	Std. Dev.	1.0186	2.13930	4.02976
Estonia	Mean	12.5179	79.4459	61.4329
	Maximum	14.8059	82.9772	67.4835
	Minimum	10.6085	75.4449	54.6999
	Std. Dev.	1.2544	2.36094	4.04260
Hungary	Mean	4.9839	72.2871	59.56935
	Maximum	5.7485	78.8646	62.5481
	Minimum	4.1179	64.2532	55.0749
	Std. Dev.	0.5322	4.81834	2.17034
Latvia	Mean	3.5827	70.4504	55.5037
	Maximum	4.0618	73.8326	56.9494
	Minimum	2.9270	63.8573	53.0532
	Std. Dev.	0.2937	2.5979	1.2450
Lithuania	Mean	3.7539	72.6050	59.1822
	Maximum	4.1370	77.3817	61.2563
	Minimum	3.0032	65.6688	55.9387
	Std. Dev.	0.3386	3.16905	1.61321
Poland	Mean	7.9241	71.3075	57.6828
	Maximum	8.2470	75.0620	61.1279
	Minimum	7.5144	66.1412	54.6009
	Std. Dev.	0.2520	2.72999	2.17127
Romania	Mean	4.11540	50.1872	51.5218
	Maximum	4.6683	54.3944	53.3686
	Minimum	3.5868	44.0227	47.6706
	Std. Dev.	0.3903	3.01943	1.70976
Slovak Republic	Mean	6.5278	71.4208	58.1412
	Maximum	7.1725	73.5764	61.8875
	Minimum	5.6194	67.1901	53.8356
	Std. Dev.	0.5566	1.69027	2.75126
Slovenia	Mean	7.4612	76.61015	68.6316
	Maximum	8.6033	78.5454	74.7581
	Minimum	6.3822	74.9362	61.4815
	Std. Dev.	0.6131	1.12124	4.33385

In the econometric analysis section of this paper, the *LM* bootstrap co-integration test by Westerlund and Edgerton [53] was employed to explore the effect of institutions and human capital on CO_2 emissions. The *LM* bootstrap co-integration test was chosen because it allows for autocorrelation and heteroscedasticity and produces more robust results for small samples. Furthermore, the co-integration coefficients were estimated by the AMG (Augmented Mean Group) estimator of Eberhardt and Bond [54] and Eberhardt and Teal [55] in view of their heterogeneity and cross-sectional dependency.

The co-integration relationship among institutions, human capital, and CO_2 emissions was examined by the *LM* bootstrap co-integration test of Westerlund and Edgerton [53]. The *LM* bootstrap co-integration test considers the cross-sectional dependency. The Westerlund and Edgerton [53] *LM* bootstrap co-integration test is based on the Lagrange multiplier test of McCoskey and Kao [56]. The *LM* bootstrap co-integration test produces biased results in the case of cross-sectional dependency and a standard normal distribution is also very susceptible to serial correlation. Therefore, the bootstrap approach is used instead of the standard normal distribution in order to overcome these problems.

4. Results and Discussions

The check for cross-sectional dependency and heterogeneity among the series employed in the study is important for the specification of further econometric tests such as the unit root and co-integration tests. Therefore, cross-sectional dependence was investigated using tests of *LM*, $LM_{adj.}$ and *LM* CD developed by Breusch and Pagan [57], Pesaran [58], and Pesaran et al. [59], respectively, and the tests' results are shown in Table 4. The null hypothesis of cross-sectional independency was reduced at 1% in light of all three tests and in turn we determined that there existed cross-sectional dependency among the three series.

Table 4. Cross-sectional-dependence tests' results.

Test	Test Statistic	*p*-Value
LM	212.1	0.0000
LM CD *	13.22	0.0000
LM_{adj} *	31.92	0.0000

* two-sided test.

The presence of homogeneity was checked by the homogeneity tests of Pesaran and Yamagata [60] after cross-sectional dependency, and both test results are shown in Table 5. The null hypothesis of homogeneity was reduced at 1%. Therefore, the co-integrating coefficients were discovered to be heterogeneous.

Table 5. Homogeneity tests' results.

Test	Test Statistic	*p*-Value
$\widetilde{\Delta}$	12.612	0.000
$\widetilde{\Delta}_{adj.}$	14.194	0.000

The presence of a unit root in the series was checked with the CIPS (Cross-Sectional IPS) [61] unit test by Pesaran [62] due to the existence of cross-sectional dependence among the variables, and the test findings are shown in Table 6. The test results indicated that the series of *LNCO, LNINST,* and *LNHUMAN* were I (1).

Table 6. Panel CIPS unit root test's results.

Variables	Level		First Differences	
	Constant	Constant + Trend	Constant	Constant + Trend
LNCO	1.706	−0.900	−6.180 ***	−5.366 ***
LNINST	−1.714	0.065	−4.307 ***	−3.087 ***
LNHUMAN	−0.925	1.230	−3.307 ***	−2.860 ***

*** It is significant at 5% significance level.

The co-integration relationship among institutions, human capital, and CO_2 emissions was analyzed through the *LM* bootstrap co-integration test by Westerlund and Edgerton [53] in view of the existence of cross-sectional dependency and heterogeneity, and the test findings are shown in Table 7. The test findings verified the importance of the second-generation co-integration test, because the bootstrap probability values were considered in case of cross-sectional dependency. Therefore, the null hypothesis of significant co-integration among the three series was accepted and we reached a significant co-integration relationship among the three variables.

Table 7. Westerlund and Edgerton [53] *LM* Bootstrap co-integration test results.

	Constant			**Constant + Trend**		
LM_N^+	Test statistic	Asymptotic p-value	Bootstrap p-value	Test statistic	Asymptotic p-value	Bootstrap p-value
	1.292	0.098	0.846	4.045	0.000	0.990

Note: Bootstrap probability values were derived from 10.000 repetitions, while asymptotic probability values were obtained from standard normal distribution. Lag and lead values were taken as 2.

The co-integration coefficients were estimated by the AMG estimator of Eberhardt and Teal [55] and the CCEMG (Common Correlated Effects Mean Group) estimator of Pesaran [63] in view of the cross-sectional dependency, heterogeneity, and robustness of the findings. The estimations of the AMG estimator are presented in Table 8, because similar coefficients were estimated by the two estimators. The co-integration coefficients revealed that institutions had a negative impact on CO_2 emissions only in Czech Republic, but a significant positive impact on CO_2 emissions in Latvia and Lithuania, and no significant impact in the other countries. On the other hand, the results indicated that human capital had a considerable decreasing impact on CO_2 emissions in Croatia, Czech Republic, Hungary, and Slovenia, but a positive impact on CO_2 emissions in Latvia and Lithuania.

Table 8. Estimation results of co-integration coefficients.

Countries	***LNINST***	***LNHUMAN***
Bulgaria	−0.7209	0.3208
Croatia	0.6043	−2.8286 ***
Czechia	−0.2793 *	−1.2560 ***
Estonia	0.2447	0.6377
Hungary	−0.1082	−2.7003 ***
Latvia	0.7497 ***	2.2568 ***
Lithuania	0.6726 **	1.7027 ***
Poland	−0.0855	0.3368
Romania	−0.1769	−1.6254
Slovak Republic	−0.1156	−1.5807
Slovenia	1.2169	−0.5567 ***
Panel	0.1819	−0.4811

***, **, * indicates that it is respectively significant at 1%, 5%, and 10%.

Institutions and human capital play a critical role in the design, implementation, and control of environmental policies, because environmental policies are mainly carried out and controlled by institutions and human capital. On the other hand, institutions and human capital are also significant determinants of economic growth. In this regard, the net effect of institutions and human capital on the environment can be varied depending on the current economic-development level of the countries in the sample, according to the EKC hypothesis. However, most scholars have revealed a positive impact of institutions and human capital on environmental quality in the related literature. Additionally, the findings of the co-integration analysis about the institution–environment nexus contradicted the findings of most of the studies in the related empirical literature, because most of the scholars such as Tamazian and Rao [31], Lau et al. [32], Gill et al. [33], Ahmed et al. [36], Nkengfack et al. [37], Simionescu et al. [38], Wu and Madni [28], and Sah [39] revealed a negative effect of institutions on CO_2 emissions. However, we revealed a decreasing effect of institutions on CO_2 emissions only in Czechia. On the other hand, we revealed that institutions raised the CO_2 emissions in Latvia and Lithuania, which was in agreement with Cole [40], Goel et al. [41] and Nguyen et al. [29]. The rising impact of institutions on CO_2 emissions indicated that the growth effect of institutional development dominated the environmental effects of institutions.

On the other hand, the findings of the co-integration analysis about the human capital–environment nexus were compatible with the theoretical and empirical findings of Bano et al. [42], Li and Ouyang [44], Yao et al. [45], Zhang et al. [46], and Joof and Isiksal [49]. However, human capital considerably raised the CO_2 emissions in Latvia and Lithuania. We evaluated that this effect could have resulted from the environment-deteriorating effect of human capital outweighing its positive environmental effect in these two countries.

5. Conclusions and Policy Implications

The globalized world is encountering the serious environmental problems of air pollution, climate change, deforestation, species extinction, soil degradation, overpopulation. Environmental quality is important not only for health, but also for sustainable economic growth and development. Therefore, extensive studies have been conducted in order to reveal the factors underlying the environmental degradation and to develop measures for improvements to environmental quality. In this context, many institutional and economic factors have been documented as possible determinants of environmental degradation, mainly proxied by CO_2 emissions. Furthermore, legal and market-based instruments have been developed to raise the environmental quality.

In this study, we focused on the ultimate environmental effects of institutions and human capital in a sample of EU transition economies, in view of their critical roles in the design, implementation and control of environmental policies, and the related limited empirical literature. The related empirical studies have generally proxied institutions by using worldwide governance indicators of the World Bank, but we proxied institutions using the institution score of UNCTAD, unlike the related literature. Furthermore, we employed a second-generation co-integration test and estimator that considered the presence of cross-sectional dependence and heterogeneity in the dataset, and country-level coefficients were also obtained. However, a limitation in this study was the limited period of 2000–2018, because the data of institutions and human capital only refer to this time, which should not be considered in the context of this research.

The co-integration analysis showed that institutional development decreased the CO_2 emissions only in Czechia, which made a significant institutional improvement during the study period, similar to most of the empirical findings. However, institutions raised the CO_2 emissions in Latvia and Lithuania and may have resulted from the growth effect of institutions outweighing their environmental effects. The findings also indicated that most of the countries have not reached their threshold level to experience the improvements to environmental quality through institutions.

On the other hand, human capital had a considerable decreasing impact on CO_2 emissions in Croatia, Czechia, Hungary, and Slovenia, in agreement with the theoretical and empirical findings. However, human capital raised the CO_2 emissions in Latvia and Lithuania. The EU transitions have generally experienced significant improvements to human capital, but the improvements to institutions lagged behind during the study period. Furthermore, the findings also indicated that the countries have not reached their threshold level of economic development to experience the improvements to environmental quality in view of the EKC hypothesis

The related theoretical considerations and empirical literature pointed out that both institutions and human capital have critical roles in achieving the improvements to environmental quality, and our findings partially verified these considerations because some countries in the sample still need to make progress in terms of their institutions and human capital. However, both institutions and human capital are significant determinants of economic growth and development. In this context, the countries can yield environmental gains from improvements to institutions and human capital after reaching the threshold referred to by the environmental Kuznets curve. Future studies can be conducted with a panel consisting of low-, middle- and high-income countries in order to see the effect of country-specific characteristics on the interaction among institutions, human capital, and CO_2 emissions.

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