Romanian Journal of Regional Science
Vol. 17, No. 1, Summer 2023

DOI: https://doi.org/10.61225/rjrs.2023.03

GLOBALIZATION AND POLLUTION IN CENTRAL AND EASTERN EUROPEAN EU COUNTRIES

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Abstract

Pollution and globalization are current challenges for Central and Eastern Europe (CEE), especially in the context of negative effects of globalization on environment. The aim of this paper is to assess the impact of globalization index on CO2 emissions in the CEE countries that joined the EU in the period 2005-2021. The results based on a panel data approach with DOLS/FMOLS estimators confirm the hypothesis that globalization enhances pollution in this region, but a non-linear relationship was validated between CO2 emissions and globalization index. After reaching a maximum level, the CO2 emissions begin to decrease, while globalization enhances. On the other hand, economic freedom and electricity prices in household consumers had a positive impact on pollution. Renewable energy consumption has the capacity to reduce pollution, while higher electricity prices for non-household users discourage economic activities, which contribute to environmental protection. These empirical findings could support policy proposals to reduce pollution in this region.

Keywords: pollution, CO2 emissions, globalization, electricity price, economic freedom

JEL Classification: C53, Q52, Q53

1. Introduction

Pollution and globalization are considered among the current challenges at world level and their effects are observed in Central and Eastern Europe. Most of the previous studies make a separate analysis of pollution and globalization, but recent paper provides empirical evidence on their relationship (Güngör et al., 2021). After the end of the communism, CEE countries adopted strategies and policies to support international trade and foreign direct investment which transform this region from an isolated one to globally interconnected community. The integration into the EU represents a step forward in the globalization process that supports economic growth. However, globalization might be harmful for the environment and this hypothesis should be checked on empirical data. In this context, the aim of this paper is to evaluate the impact of globalization index on CO2 emissions in the CEE countries that joined the EU (Bulgaria, Slovenia, Romania, Poland, Hungary, Slovakia, Czechia, Lithuania, Estonia, Latvia, Croatia in the period 2005-2021. Since energy prices are another current challenge for these countries, electricity price is included in the panel data models as control variable.

The connection between globalization and pollution is analyzed in the context of the debate between economic growth and CO2 emissions, but also separately, to check the linear and non-linear relationship. Since the cointegration assumption is checked, the panel data models are based on DOLS/FMOLS estimators. The results confirm the harmful effect of globalization on environment and the policy recommendations should force foreign investors to focus more on environmental protection by using green technologies and not only on profit maximization. Since pollution affects ecosystem and human health, any initiative should be consider in the fight with this phenomenon. Moreover, the pollution reduction is directly related to the European objective to achieve net-zero GHG emissions by 2050 and the CEE countries that joined the EU should enhance the environmental and economic initiatives to contribute to the achievement of this common target.

After this introduction, the paper makes a short presentation of the literature review focusing on the debate related to the effects of globalization on pollution. The next sections describe methodology, data and results, discuss the empirical findings and provide final conclusions.

2. Literature review

This paper starts from the theoretical background supported by environmental Kuznets curve (EKC). According to theoretical approach, in the first stage of economic growth, the pollution increases, but after a certain threshold of income it decreases, which supports the inverted U-shaped relationship between pollution and growth. However, the empirical findings may support this hypothesis or not. We are particularly interested in the previous studies for developing countries in the Central and

Eastern Europe, because the sample of countries under analysis is placed in this region and in this category of states despite the rapid economic progress. An inverted N and an U patterns was proved by Simionescu (2021) for seven New EU Member States in the period 1990-2019. Mixed results were identified by Lazar et al. (2019) for CEE countries in the period 1996-2015: N shape for Bulgaria, Czech, Croatia, Hungary, Estonia, Latvia, Romania, and Slovenia) and inverted-N shape for Lithuania, Poland, Slovakia.

The EKC has been extended to capture the impact of other economic, energy and social indicators on environment. In most of the studies CO2 emissions are used as proxy for pollution, even there are few studies in literature that focused on GHG emissions, SO2 emissions, ecological footprint etc. (Simionescu, 2021). A major extension of EKC supposed the inclusion of renewable energy consumption among explanatory variables which is in line with European directives that establish to quantify the effect of renewables on environment and the progress in achieving the European targets. Therefore, the baseline model used in this paper includes GDP, GDP square and renewable energy consumption. Most of the control variables in the extended model refer to economic indicators. Given the common political history of the CEE countries and their transition to functional market economy after 1990, economic freedom is considered an important indicator that has enhanced entrepreneurial initiatives and, consequently, affected the environment. The index of economic freedom provided by Heritage was previously used in extended EKX by Husain Tahir et al. (2021), Majeed et al. (2021), Simionescu (2021) etc. the empirical results supported the hypothesis that economic freedom enhances pollution in Asia-Pacific region, Pakistan or CEE countries. However, the main aim of this paper is to quantify the impact of globalization of CO2 emissions starting from a debate in literature. The first current supports the hypothesis globalization has many benefits for any country and the correct management of environmental issues will bring no harmful effects on environment. The benefits of globalization are related to productivity growth, fostering economic development, improvement in living conditions, housing, transportation and communications. The second current does not deny the benefits of globalization, but argue that it promotes more the economic development, but without any concern on environmental protection (Güngör et al., 2021). In this context, the effect of globalization o environment remains uncertain and an empirical evaluation is necessary for any country or region. There are two groups of studies that provide evidence on positive impact and negative impact, respectively o globalization on pollution. The studies might refer to one country or to a sample of countries.

First, few papers provide empirical evidence on positive impact of globalization on pollution because of increased urbanization, with new transportation networks, leading to deforestation and loss of biodiversity. In the case of India, Shahbaz et al. (2015) empirically confirm that globalization contributed to increase in CO_2 emissions in the period 1970-2012, while the same conclusion was drawn by Adebayo and Acheampong (2022) in their study for Australia using time series from 1970 to 2018. The hypothesis was supported even for groups of countries like NAFTA in the period of 1990-2015 (Kalaycı and Hayaloğlu, 2019) and in 5 South Asian countries during 1985-2018 using FMOLS approach (Wen et al., 2021).

Second, there are other studies that support the hypothesis that globalization is beneficial in reducing CO_2 emissions. The papers refer to a single country. For example, some studies made for China concluded that globalization reduces CO_2 emissions: paper of Shahbaz et al. (2017) based on Bayer and Hanck combined cointegration test and ARDL (Autoregressive Distributed Lag) model in the period 1970-2012 and the study of Saliba et al. (2022) based on ARDL model, FMOLS and DOLS estimators in the period 1990-2019. For Italy, Saint Akadiri et al. (2019) used an ARDL model and Toda and Yamamoto methodology for causality for time series corresponding to the period 1970-2014 and found out that an increase in the globalization index reduces CO_2 emissions.

Besides these linear connections between globalization and pollution, there are other studies that considered the non-linear relationship between these two variables. More papers has established an inverted U-shaped relationship between globalization and CO_2 emissions for different samples of countries. For example, Liu et al. (2020) validated an inverted U pattern in their study for G7 countries. A complex study of Shahbaz et al. (2019) analysed 87 countries and found out inverted U-shape for 16 countries (middle and high income), U-shaped relationship for seven states in the sample and neither of these two forms for the rest of the countries in the sample.

In this paper, the linear and non-linear relationship between CO_2 emissions and globalization index will be checked. Since empirical evidence showed no strong connection between GDP and globalization index, the variables could be used in the same model in the extended EKC form. Moreover, another model will be considered to include globalization index and globalization index square.

3. Method and data

The research is based on panel data in the period 2005-2021 for 11 EU countries located in the Central and Eastern Europe: Bulgaria, Hungary, Poland, Croatia, Romania, Czechia, Estonia, Latvia, Lithuania, Slovakia, and Slovenia. The baseline model based on EKC considers a polynomial function of order 2 and renewable energy consumption as control variable. The model is extended by adding other variables like index of economic freedom, globalization index, electricity prices Kilowatt-hour for household consumers or for non-household consumers. Additional models consider only index of economic freedom, globalization index, renewable energy use and electricity prices.

The non-linear relation between CO2 emission and globalization index is also checked using a polynomial function of order 2. All the data series are taken in the natural logarithm to reduce the multicolliniarity:

$$CO2_{it} = \alpha_i + \beta_1 \cdot GDP_{it} + \beta_2 \cdot GDP_{it}^2 + \beta_3 \cdot RC_{it} + \beta_4 \cdot X_{it} + e_{it} \quad (1)$$

CO2- carbon dioxide emissions; GDP- gross domestic product; RC- renewables per capita consumption; X-vector of control variables

α -country-fixed effects

$\beta_1, \beta_2, \beta_3, \beta_4$- parameters

e_{it}- error

i-index for country, t-index for year

The non-linear relationship between globalization index and CO2 emissions is represented as:

$$CO2_{it} = a_{1i} + b_1 \cdot GI_{it} + b_2 \cdot GI_{it}^2 + b_3 \cdot RC_{it} + b_4 \cdot IEF_{it} + b_5 \cdot EP\_hc_{it} + e_{1it} \quad (2)$$

$$CO2_{it} = c_{1i} + d_1 \cdot GI_{it} + d_2 \cdot GI_{it}^2 + d_3 \cdot RC_{it} + d_4 \cdot IEF_{it} + d_5 \cdot EP\_nhc_{it} + e_{2it} \quad (3)$$

The significance of the variables is presented in Table 1. CO2 is used as proxy for pollution. The Globalization Index is an aggregate measure of social, economic and political globalization. It is an index with values between 0 and 1. Globalization enhances competition and more entrepreneurial initiatives which determines more pollution in the absence of clean technologies.

Table 1. The variables of the model

Variable notation (data series in natural logarithm)	Description	Data source
CO2	Carbon dioxide emissions	World Bank World Resources Institute
GDP	Gross domestic product in constant prices (constant 2017 international $)	World Bank
IEF	Index of economic freedom	Heritage Foundation
RC	renewables per capita consumption	World Bank
GI	The Globalization Index	KOF Swiss Economic Institute

EP_hc	electricity prices Kilowatt-hour for household consumers	Eurostat
EP_nhc	electricity prices Kilowatt-hour for non-household consumers	Eurostat

Source: Own representation.

Preliminary tests should be applied to identify the most suitable panel data models. Cross-sectional dependence, slope heterogeneity, and unit root tests. Under cross-sectional dependence checked with Pesaran's CD test (Pesaran, 2015) and heterogeneity according to Pesaran and Yamagata (P-Y) test (Pesaran and Yamagata, 2008), for data series integrated of the same order, cointegration is checked using Westerlund test.

If cointegration is confirmed, DOLS/FMOLS estimators could be employed. The Fully Modified Least Square (FMOLS) manages the heterogeneous cointegration, while the heterogeneous FMOLS estimator of Pedroni (2001) makes the correction of endogeneity bias and autocorrelation. DOLS and FMOLS estimators have the same asymptotic distribution.

For N cross-sections (i=1,2,..,N), a cointegrated system in panel is defined:

$$y_{it} = \alpha_i + \beta x_{it} + \mu_{it} \quad (4)$$

$$x_{it} = x_{it-1} + e_{it} \quad (5)$$

Vector error $\varepsilon_{it} = (\mu_{it}, e_{it})'$ is I(0)

Ω_i- asymptotic covariance matrix associated to vector error

x_i - vector (m x 1) with uncorrelated values

$x_i \; and \; y_i$ are cointegrated for any cross-section

For one unit root in the series of y_{it}, β is the cointegrating vector

α_i allows the presence in the cointegrating equation of country fixed specific effects. $\varepsilon_{it} = (\mu_{it}, e_{it}{}')$ is partitioned (the first value is a constant and the rest ones are represented by a vector (m x 1) for the differences in the values of regressors $\varepsilon_{it} = \Delta x_{it} = x_{it} - x_{it-1}$).

Covariance matrix Ω_i is:

$$\Omega_i = \begin{bmatrix} \Omega_{11i} & \Omega'_{21i} \\ \Omega_{21i} & \Omega_{22i} \end{bmatrix}$$

Ω_{11i}: scalar long term variance for μ_{it}

Ω_{21i}: vector (m x 1) reflecting the long-run covariance between e_{it} and μ_{it}

Ω_{22i} : (m x m) long term covariance among the e_{it}

The Asymptotic Bias of the Panel OLS Estimator of the parameter β under invariance principle and cross-sectional independence is:

$\hat{\beta}_{NT} = [\sum_{i=1}^{N}\sum_{t=1}^{T}(x_{it} - \bar{x}_i)^2]^{-1} \cdot \sum_{i=1}^{N}\sum_{t=1}^{T}(x_{it} - \bar{x}_i)(y_{it} - \bar{y}_i)$ (6)

$\bar{x}_i, \bar{y}_i$- individual averages

The Asymptotic Distribution of the Pooled Panel FMOLS Estimator of β is computed as:

$$\hat{\beta}*_{NT} - \beta = [\sum_{i=1}^{N}\hat{L}_{22i}^{-2}\sum_{t=1}^{T}(x_{it} - \bar{x}_i)^2]^{-1}\sum_{i=1}^{N}\hat{L}_{11i}^{-1}\hat{L}_{22i}^{-1}(\sum_{t=1}^{T}(x_{it} - \bar{x}_i)\mu_{it}^{*} - T\hat{\gamma}_i) \quad (7)$$

$$\mu_{it}^{*} = \mu_{it} - \frac{\widehat{L_{21i}}}{\widehat{L_{22i}}}\Delta x_{it} \quad (8)$$

$$\hat{\gamma}_i \equiv \widehat{\Gamma_{21i}} + \hat{\Omega}_{21i}^{0} - \frac{\widehat{L_{21i}}}{\widehat{L_{22i}}}(\widehat{\Gamma_{22i}} + \hat{\Omega}_{22i}^{0}) \quad (9)$$

$\hat{L}_i$: lower triangular decomposition of $\hat{\Omega}_i$

Considering invariance principle and cross-sectional independence fulfilled, one may conclude:

$$T\sqrt{N}(\hat{\beta}_{NT}^{*} - \beta) \sim N(0, v) \quad (10)$$

v=2, if $\bar{x}_i = \bar{y}_i = 0$ and v=6 else, where $N \to \infty, T \to \infty$

The descriptive statistics in Table 2 show high range for CO2 and this is explained by the progress made in time by these countries to reduce pollution. If in the first years of the period the levels of CO2 were higher, in the last years the levels have decreased due to environmental policies and the higher consumption of renewable energy that reduces pollution.

Table 2. Descriptive statistics for data in natural logarithm (2005-2021)

Variable	Mean value	Std. deviation	Minimum value	Maximum value
CO2	10.55	1.09	8.85	12.66
GDP	10.21	0.23	9.86	10.65

IEF	4.21	0.08	3.99	4.41
RC	0.75	0.98	-1.16	2.18
EP_nhc	-2.52	0.21	-2.98	-1.99
EP_hc	-2.36	0.22	-2.78	-1.99

Source: Own calculations

The higher value for growth in CO2 emissions was reached by Poland in 2010. Despite the global economic crisis, Poland did not face recession, but struggled to maintain the economic activities even neglecting the environmental protection for fear of a potential economic crisis.

4. Results and Discussion

Table 3 confirms that the cross-sectional dependence is checked for all data series at 1% significance level. Moreover, the slope heterogeneity is confirmed for almost all variables at 5% significance level. The exception is represented by CO2, EP_hc and EP_nhc.

Table 3. The cross-sectional dependence and heterogeneity tests

Indicator	CD test stat.	p-value	P-Y test stat.	p-value
CO2	19.54	<0.01	-0.845	0.40
GDP	27.03	<0.01	-2.17	0.04
GI	17.93	<0.01	2.29	0.018
IEF	8.67	<0.01	2.39	0.017

RC	19.05	<0.01	2.45	0.02
EP_hc	5.35	<0.01	0.59	0.55
EP_nhc	7.58	<0.01	0.33	0.86

Source: own calculations in Stata 15

Under cross-sectional dependence, the second generation panel unit root tests should be employed and CADF test is used in this case. The test is applied with one and two lags because of its sensitiveness to the number of lags. The results in Table 4 suggest that the panel data in level are integrated of order one at 5% significance level.

Table 4. The results based on CADF test

Indicator	Data in level (constant+ trend)		Data in the first difference (constant)	
	one lag	two lags	one lag	two lags
CO2	-1.68	-1.72	-2.40**	-2.53**
GDP	-1.22	-1.72	-2.37**	-2.32**
RC	-2.35	-2.23	-2.41**	-2.72**
GI	-1.73	-1.72	-2.58**	-2.53**
IEF	-1.73	-1.71	-2.32**	-2.34**
EP_hc	-1.71	-2.18	-2.92 **	-2.59**
EP_nhc	-1.71	-1.72	-2.97**	-2.32**

Source: Own calculations in Stata 15. Note: ** shows p-value less than 0.05.

For the data series integrated of order 1, the cointegration is verified using the Westerlund test that is robust to cross-sectional dependence. Table 5 indicates that three out four statistics of the test confirm the cointegration between data series.

Table 5. Cointegration based on Westerlund test

Statistics	Cointegration between CO2 and:			
	GDP, IEF, RC, GI, EP_nhc	GDP, IEF, RC, GI, EP_hc	IEF, GI, RC, EP_nhc	IEF, GI, RC, EP_hc
Gt	1.78**	2.23**	2.70***	2.07**
Ga	6.78***	4.85***	7.86***	5.88***
Pt	-0.18	-0.087	0.29	0.08
Pa	1.95**	1.89**	2.49***	1.93**

Source: Own calculations in Stata 15, *** for p-value<0.01; ** for p-value<0.05; * for p-value<0.1

With cointegration supported, DOLS and FMOLS estimators are computed even if under cross-sectional dependence they provide biased and inconsistent results. More types of models are constructed: models starting from EKC formalization and models based on other explanatory variables.

According to correlation matrix, there is not a strong linear relationship between GDP and GI (coef. of correlation is 0.304). Therefore, both variables could be included in the same model. The results in Table 6 suggest U pattern in the relationship between economic growth and pollution. Variables like RC and EP_nhc had a negative impact on pollution, while GI, IEF and EP_hc exerted a positive influence. These specifications suggest that economic freedom, globalization, and electricity price growth for households intensified the economic activities with negative consequence on environment. On the other hand, increase in the price of electricity for non-households discouraged the economic activities and reduced pollution. Renewable energy consumption had a beneficial contribution to environment.

Table 6. DOLS/FMOLS estimators to explain CO2 emissions in CEEs (2005-2021) based on EKC

Variable	Coefficients					
	M1		M2		M3	
	DOLS	FMOLS	DOLS	FMOLS	DOLS	FMOLS

GDP	- 109.01***	- 27.581***	- 72.173***	- 32.808***	- 169.061***	- 26.428***
GDP^2	5.4***	1.272***	3.595***	1.502***	8.253***	1.267***
IEF	-	-	3.675***	0.278*	3.076***	0.191*
GI	-	-	7.14***	1.111*	6.315***	0.555***
GI^2	-	-	-		-	-
RC	-0.976***	-0.219*	-0.728***	-0.154*	-0.603***	-0.113*
EP_nhc	-	-	-0.895***	-0.697**	-	-
EP_hc	-	-	-	-	2.702***	1.063*

Source: Own calculations in Stata 15. Note: * for p-value less than 10%; ** for p-value less than 5% level;*** for p-value less than 1%.

The results in Table 7 suggest the same patterns in this sample of countries in the period 2005-2021. Economic freedom and globalization contributes to pollution, while electricity prices for households have a significant and positive impact on CO2 emissions. Renewable energy consumption continues to play a significant role in the fight against pollution in this specification of the models. The increase in electricity prices for non-households consumers reduces pollution, because these companies reduce their activity. Moreover, a non-linear relationship is observed between globalization index and CO2 emissions after an inverted U-pattern.

Table 7. DOLS/FMOLS estimators to explain CO2 emissions in CEEs (2005-2021) based on globalization index

Variable	Coefficients							
	M4		M5		M6		M7	
	DOLS	FMOLS	DOLS	FMOLS	DOLS	FMOLS	DOLS	FMOLS
IEF	3.509***	0.454***	3.323***	2.293***	3.297***	0.526***	2.847***	0.339***
GI	4.925***	3.566***	4.246***	3.703***	580.725***	46.494***	796.570***	60.558***

GI^2	-	-	-	-	-66.312***	-5.283***	-77.758	-6.939***
RC	-0.813***	-0.911***	-0.776***	-0.779***	-0.940***	-0.118**	-0.941***	-0.092*
EP_nhc	-1.165***	-0.87**	-		-1.018***	-0.053*	-	-
EP_hc	-	-	1.053***	0.203***	-	-	1.243***	0.118***

Source: Own calculations in Stata 15. Note: * for p-value less than 10%; ** for p-value less than 5% level;*** for p-value less than 1%.

All in all, few conclusions could be drawn if both approaches are considered. The increase in electricity prices for non-households have the capacity to reduce CO2 emissions, while higher electricity prices for households might determine people to work more to pay the utility bills and this situation might generate more pollution. More renewable energy consumption should be promoted since it plays a significant role in the improvement of environmental quality. Economic freedom and globalization act like drivers for competition between companies that enhance their economic activities, but without a significant concern for keeping a clean environment.

The results are in line with previous studies. The positive impact of growth, economic freedom and globalization has been previously showed for other panels of countries, while renewable energy consumption was proven to be the most efficient tool in managing CO2 emissions.

The economic growth enhances pollution in this case because of the lack of green technology and the inexistence of a strong legislative background to support environmental policies. The same U pattern was previously found by Simionescu (2021) over 1990-2019 in the case of seven CEE countries that are also included in this paper. Moreover, Lazar et al. (2019) indicated a U pattern for some CEE countries (Bulgaria, Latvia) and an inverted one for other CEE states (Romania, Lithuania, Czechia, Hungary, Lithuania, Slovenia) in the period 1996-2015.

The direct impact of economic freedom on CO2 emissions has been proved in previous papers for developed countries (Carlsson and Lundström, 2001), OECD countries (Joshi and Beck, 2018) and India in the period 1980-2012 (Sajeev and Kaur, 2020). This connection that is harmful for the environment might be explained by the fact that economic freedom encourages business initiatives, but the entrepreneurship is not too much focused in investing in green technology to reduce environmental impact of the economic activities. The policies should encourage more the acquisition of non-polluting technology and subsidies might be assigned to companies that want to extend more their activities.

The harmful effect of globalization by increasing pollution was documented in other studies made for groups of countries (South Asian countries in Wen et al. (2021) or NAFTA countries in Kalaycı and Hayaloğlu (2019)) or for a single country (India in Shahbaz et al. (2015) and Australia in Adebayo and Acheampong (2022)). The arguments for the harmful impact of globalization on environment are related to deforestation, fast urbanization, loss of biodiversity, development of transportation networks. However, our findings show that after reaching a maximum level of pollution because of globalization, the CO2 emissions begin to decrease. The decline of pollution in the long-run when globalization continues might be argued by the fact that the high competition on market and European legislation force the companies to promote and use green technologies that are environmental-friendly.

The capacity of renewable energy consumption to reduce pollution (CO2 emissions) has been empirically demonstrated in many previous studies that refer to developing countries (in seven New EU Member States, including our sample of countries in the period 1990-2019 by Simionescu (2021), in 12 Middle East and North Africa countries during 1980–2012 in Kahia (2019), in 25 major developing countries in the period 1996-2012 by Hu et al. (2018), in 46 Sub-Saharan African states in the period 1980-2015 in Adams and Acheampong (2019)), but also to developed states (in G7 countries in the period 1980-2005 by Sadorsky (2009), in few G20 countries during 1990-2019 by Jamil et al. (2022)). The efficiency of renewable energy use in reducing pollution is explained also by the EU efforts to enhance renewable use and achieve the targets in consumption for managing GHG emissions and climate changes.

The positive impact of electricity price in the case of has been previously empirically documented by Lien (2022) for Norway, who showed that electricity tariff abolition will generate more CO2 in this country. For electricity prices in the case of non-household consumers, Kisswani (2022) indicated a negative impact on CO2 emissions, which is the same result as in this study.

These results have social and economic implications. The economic growth determines more pollution which has harmful effects on environment as well as on people's health. The air pollution in CEE countries causes respiratory and cardiovascular issues with significant impact on life expectancy. Moreover, premature deaths were reported in the most serious cases, lung cancer being a problem encountered in CEE states more than in the rest of the European countries. The European Green Deal's Zero Pollution Action Plan fixed ambitious goals to achieve zero net GHG emissions and less premature deaths caused by air pollution, but more actions are required at national level to reach these targets. The directives related to air quality has been revised and more attention is paid to pollution in each economic sector. However, CEE countries should consider more actions to achieve the European goals. The renewable energy use has increased fast in the last decade, but more actions are necessary to achieve a more beneficial impact on environment. In this case, each CEE country should focus more on the type of renewable energy source that is dominated in that country. However, biomass burning might be a source of pollution and this phenomenon should be minimized. Globalization is harmful for environment in the short-run and each state should improve the policy framework to reduce the economic activities that provide significant levels of pollution. Higher electricity prices discourage the expansion of some companies, but more efficient instruments should be used to promote green technologies and more sanctions for high polluters.

5. Conclusion

This paper discusses the issue of globalization in the context of pollution for countries in Central and Eastern Europe that are EU member states. As expected, the globalization index had a positive impact on pollution in the period 2005-2021. Moreover, economic freedom enhanced CO_2 emissions, while renewable energy consumption reduced pollution. Another challenge for pollution is represented by electricity prices. However, different patterns are observed depending on the users of electricity. If the users are households, the rise in the electricity price enhances pollution, while in the case of non-household consumers, the increase in electricity price discourage economic activities and, consequently, reduces pollution.

Given the harmful effects of pollution on environment and population health in CEE countries, more policy recommendations are necessary. The economic and climate policies are an important tool in the fight against pollution. First, the integration of green growth in the EU remains an ongoing process, but more efforts are necessary to address the green growth priority: higher taxes for CO_2 emissions and fossil fuel use, faster inclusion of transport into the Emissions Trading System. Green growth should be promoted more by accelerating the deployment of the renewable energy sources and stimulating green investment and finance. Second, climate policies should be improved to transform the cities in these countries into climate-friendly and clean air spaces for the population. Since globalization affects the environment in CEE countries, cooperation between states is essential and an international environmental policy should be a priority for all foreign investor in CEE countries. This type of policy should take into account sustainable energy policy, mitigation of climate changes, conservation of soils, forests and seas, promotion of biological diversity. Renewable energy consumption growth was supported in the EU to manage climate changes, but more progress in specific national policies is also required to achieve the 2050 EU targets. More financial support should be given to the poorest households with limited access to electricity, while non-household consumers should be aided to implement clean technology. Easier access to government subsidies to promote the green technology innovation and products is required to have less pollution from economic activities and from the use of environmentally friendly products by population.

Besides the novelty of these results for this region, the study is subject to few limitations. For example, DOLS/FMOLS approach might provide biases and inconsistent estimations. A limited number of control variables are introduced in the models depending on the data availability. The EKC formalization is considered under a polynomial function of order two and not of order three. The data availability allows us to use a panel data approach, without a separate analysis for each country. Therefore, future directions of research might include: the use of other types of estimators for robustness check, the use of EKC specification with a polynomial function of order three, a comparative analysis with Old EU Member States, the use of more control variables (human development index, foreign direct investment etc.).

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