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Impact of Institutional Factors on Environmental Quality in European Union

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ABSTRACT

Environmental quality deterioration due to negative externalities arising from the economic growth process can be minimized in economies with high institutional quality. This study examines the institutional factors affecting environmental quality in European Union countries in the period 2002-2022. According to the panel unit root test, regulatory quality and voice and accountability variables are stationary at level values. In the short-run, there is no causality from institutional quality determinants (Control of Corruption, Rule of Law, Regulatory Quality, Voice and Accountability) to environmental quality in all European Union countries. However, in the long-run, there is causality from institutional factors to environmental quality as a whole. According to the panel parameter estimation method sensitive to cross-sectional dependence, institutional factors have no effect on environmental quality in Bulgaria, Croatia, Estonia, France, Germany, Sweden. In Finland, Ireland and Spain, institutional factors have the highest impact on environmental quality.

Keywords: Environmental Quality, Institutional Factors, European Union, Environmental Policy Making, Panel Data
JEL Classification: C13, Q53

1. INTRODUCTION

The rapid economic growth brought about by economic integration leads to environmental degradation. The negative externalities created by economic growth contradict the objective of economic policy to maximize social welfare. Therefore, economic policies that prioritize the quality of the institutional structure should be implemented. In developed economies rather than developing countries, institutional infrastructure that reduces carbon emissions and enables the adoption of a production process based on renewable energy production is trying to be established. This is because in economies where institutional quality (hereafter IQ) exists, the effects of market failures caused by negative externalities can be minimized. According to the institutional economics approach, the institutional structure has an indirect effect on environmental quality (herafter EQ) together with regulations. In economies where institutional arrangements work effectively, the impact of economic growth on EQ is minimized. On the other hand, in economies where IQ is not effective, firms do not pay enough attention to environmental quality for profit maximization. For these reasons, institutional structure has an important role in the coordination of economic policy to improve EQ. There is a positive correlation between institutional structure and EQ (Farzin and Bond, 2006). This is because institutional structure helps to create an organized society that is more sensitive to environmental conditions by helping to raise the average level of knowledge of the society. Through the rule of law and accountability, individuals can put pressure on governments to improve EQ.

The objective of this paper is to reveal the IQ affecting EQ in European Union countries with a certain economic size. With this study (1) to determine whether both EQ and institutional factors are affected by economic shocks (2) to analyze the impact of IQ factors on EQ in the short and long run (3) to obtain parameters measuring the impact of IQ factors on EQ for European Union economies.

The second section of the study categorizes studies that look into the impact of institutional regulations on EQ both theoretically and empirically. The third section presents the empirical results based on panel data analyses. In this context, we first test whether there is cross-section dependence Breusch and Pagan (1980, CD_{lm}), Pesaran (2004, CD, CD_{lm}) and Pesaran et al. (2008, LM_{adj}). Subsequently, Smith et al. (2004) "bootstrap" panel unit root test is applied to examine whether the variables are affected by economic shocks. Panel vector autoregression and panel error correction models are constructed to analyze the short (hereafter SR) and long run (hereafter LR) causality relationships between the variables. The analysis concludes by using the panel Augmented Mean Group (AMG; Eberhardt and Bond, 2009) estimator to determine the effect of each institutional factor on EQ. The final section delivers an overall evaluation and policy proposals.

2. THEORETICAL BACKGROUND AND LITERATURE REVIEW

According to North (1990), institutional structure contains formal and informal regulations. Formal constraints include laws and property rights, while informal constraints contain institutional culture and norms. The institutional structure should be considered as a whole. This includes the rights and rules that emerge at every stage of social structures that draw attention to environmental conditions. There are many studies on how to measure IQ or what can be used as a proxy variable. Lau et al. (2014), Goel et al. (2013), Akhbari and Nejati (2019), Azam et al. (2021), Uzar (2021) and Fatima et al. (2022) have used administrative capacity, property rights, CoC and RoL to measure IQ, while Kaufmann and Kraay (2024), Gwartney et al. (2012), Kaufmann and Kraay (2020) and Gwartney et al. (2012) have used a variety of political factors with different statistical methods to obtain indices. PS refers to as an indicator of IQ (Asif et al., 2023). Factors such as the political and democratic structure and electoral processes can contribute significantly to reducing environmental degradation. These structures and processes play important role in the formulation of environmental policies (Purcel, 2019). According to Dutt (2009), Gill et al. (2019), Azam et al. (2021), Su et al. (2021), there is a negative relationship between PS and EQ in the LR. Because political instability has many national and international may have unpredictable causes (Dong et al., 2021; Fredriksson and Svensson 2003). Political and economic measures taken to prevent short-term imbalances may lead to market failure in the LR. However, countries with long-term governments can implement rules and regulations on EQ more efficiently (Varoudakis et al., 2007; Dong et al., 2021; Allen et al., 2022). On the other hand, weak institutional structure hinders the effective implementation of energy and environmental policies due to increased transaction costs. According to Copeland (2005), Azimi and Rahman (2023), there is evidence that the "*pollution-haven hypothesis*," which suggests that countries with weak institutional structures have high levels of environmental pollution, is valid. This is because, due to the discretionary power of regulatory agencies, corrupt bureaucrats support choices that undermine environmental laws. Due to weak institutional structure, short-term returns are traded for long-term benefits, creating a vicious cycle of environmental degradation (Stoddart et al., 2020; Amegavi et al., 2022; Adebayo, 2022). CoC, PS and democracy -have a negative impact on EQ due to inefficiencies and sub-optimal resource utilization (Culas, 2007; Zhang et al., 2016; Joshi and Beck, 2018; Abid, 2016; Gani, 2012). Therefore, ensuring the RoL, IQ, CoC, PS, democratic practices can reduce environmental degradation and, according to Ali et al. (2022), steer energy policies towards renewable energy production. Castiglione et al. (2012) and Kerekes (2011) show that the rule of law, including property rights, has a negative correlation with environmental pollution. Fredreksson and Svensson (2003) show that political instability has a positive effect on the enforcement of environmental laws in economies with low corruption, while it has a negative effect if corruption is high. On the contrary, Halkos and Tzeremes (2013) argue that in developed countries, PS and corruption do not always tend to reduce CO_2 with increasing quality of governance.

According to Gill et al. (2019), in the initial phase of economic development, the public authority does not make proposals involving environmental regulations. Therefore, sensitivity to EQ is not prioritized by economic actors at the initial stage of development. Cole et al. (2006) and Damania et al. (2003) argue that in high-income developed countries, trade liberalization reduces the negative impact of IQ on environmental degradation. This is because the policy responsiveness brought by high income levels increases the demand for clean environmental standards through appropriately enacted laws on EQ (Panayotou, 1997; Adams and Acheampong, 2019; Lv et al. 2017). In high-income countries, economic actors' demand for EQ is considered a "normal good" (Gill et al., 2019). On the other hand, corruption and low IQ in developing countries have a negative impact on EQ (Welsch, 2004; Cole, 2007; Abid, 2016; Fotiadis, 2016). According to Congleton (1992), Li and Ruveny (2006), above a certain income level, non-liberal democracies implement fewer environmental regulations than liberal democracies. This is because the free market mechanism supported by liberal democracies stimulates economic activity and increases energy consumption and thus carbon emissions. Moreover, there is bidirectional causality between democratic practices and energy consumption when domestic income is above a certain threshold (Güngör et al., 2021). Liberalization of the foreign trade regime enables the private sector to integrate into international markets and creates pressure on the public sector to operate efficiently (Adebayo, 2022). Effective policies of the public authority originating from the private sector increase the effectiveness of environmental policies and put pressure on reducing CO_2 emissions (Bhattarai and Hammig, 2004; Adams and Klobodu, 2017; Moyer and Sinclair, 2022). The foreign trade policies of developing countries for the sustainability of economic growth lead to the import of emission-emitting investment goods and cause environmental degradation. In the SR, foreign capital inflows cause environmental degradation, but improve EQ in the LR (Emmanuel et al., 2023). According to Hunjra et al. (2020), the IQ of a country creates financial development and prevents environmental degradation as it increases the responsiveness of capital flows. According to Charfeddine and Ben Khediri (2016), Danish et al. (2019), Gill et al. (2019), the increase in technological innovation, foreign direct investment and trade openness decreases EQ. According to these studies, environmental degradation increases with the integration of the country into international markets.

3. DATA, MODEL AND RESULTS

This study investigates the institutional factors affecting EQ in EU countries in the period 2002-2023. As a measure of EQ, the carbon emission variable used in Adams and Acheampong (2019), Su et al. (2021), Dong et al. (2021) is used. As institutional factors, control of corruption (Asif et al., 2023), regulatory quality (Emmanuel et al., 2023), rule of law (Wang et al., 2018), voice and accountability (Güngör et al., 2021) variables are used.

Depending on the given definitions in Table 1, the regression we use in empirical practice;

$$\ln EQ = \beta_0 + \beta_1 CoC_{it} + \beta_2 RQ_{it} + \beta_3 RoL_{it} + \beta_4 VaA_{it} + \varepsilon_{it} \quad (1)$$

where i = 1, 2..., 27 refers to each country in the panel while t = 2002...,2022 is the time period. β_0 is the constant term; β_1, β_2, β_3 and β_4 are the slope parameters of the explanatory variables, and ε_{it} is the error term. We apply CD and LM test for cross section dependency (hereafter CSD). This situation is analyzed with the tests developed by Breusch and Pagan (1980), Pesaran (2004) and Pesaran et al. (2008). In the Lagrange Multiplier (hereafter LM) test, $LM = T\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}^2$ and

$$LM_{adj} = \sqrt{\frac{2}{N(N-1)}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N} T\hat{\rho}_{ij}^2 \frac{(T-k)\hat{\rho}_{ij}^2 - \mu_{Tij}}{\sqrt{\vartheta_{Tij}^2}}}$$

(Breusch and Pagan, 1980; Peseran et al., 2008). In CD tests, test statistics are calculated as $CD_{LM} = \sqrt{\frac{1}{N(N-1)}\sum_{i)1}^{N-1}\sum_{j=i+1}^{N}\left(T\hat{\rho}_{ij}^2 - 1\right)}$ ve

$CD = \sqrt{\frac{2T}{N(N-1)}\sum_{i)1}^{N-1}\sum_{j=i+1}^{N} T\hat{\rho}_{ij}^2}$ (Peseran, 2004). In CSD tests, the null hypothesis is that there is CSD among the countries in the panel, while the alternative hypothesis is that there is no CSD. It is necessary to determine whether carbon emissions and other institutional factors have been affected by economic shocks in the 2002-2022 period and, if so, whether this effect has been eliminated. Smith et al. (2004) "bootstrap" panel unit root test (hereafter PUR) obtains critical values by bootstrap method compared to other PUR tests. In the bootstrap PUR test, the null hypothesis allege that the variable has a UR and the alternative hypothesis allege that there is no UR. The test statistics (LM) is $\overline{LM} = N^{-1}\sum_{i=1}^{N} LM_i$ and LM is the arithmetic mean of the test statistics. With the tests developed by Breusch and Pagan (1980), Pesaran (2004) and Pesaran et al. (2008) whether the slope parameter of each country in the panel is equal to each other. In these tests, the null hypothesis alleges that the slope parameter of each country in the panel is equal (homogeneity), while the alternative hypothesis alleges that the slope parameters are different (heterogeneity). Westerlund (2007, 2008) developed a cointegration model for the null hypothesis of zero error correction term.

$$\alpha_i(L)\Delta y_{it} = \delta_{1i} + \delta_{2i}t + \alpha_i\left(y_{it-1} - \grave{\beta}_i x_{it-1}\right) + \gamma_i(L)\grave{\vartheta}_{it} + \varepsilon_{it}$$

If $\alpha_i = 0$, there is no cointegration in the model. The cointegration test is conducted to analyze whether the variables in model (1) move together in the LR. In the panel vector auto regression model (PVAR), the auto regression parameters that emerge by selecting the optimal lag length are subjected to F-test to determine the SR causality relationship. Panel error correction model;

$$\Delta EQ = \delta_{1i} + \sum_{p=1}^{k}\delta_{11ip}\Delta EQ_{it-p} + \sum_{p=1}^{k}\delta_{12ip}\Delta CoC_{it-p} + \sum_{p=1}^{k}\delta_{13ip}\Delta RQ_{it-p}$$
$$+\sum_{p=1}^{k}\delta_{14ip}\Delta RoL_{it-p} + \sum_{p=1}^{k}\delta_{15p}\Delta VaA_{it-p} + \phi_1\hat{\varepsilon}_{it-1} + v_{1t}$$

In this model, the null hypotheses for short-run causality are $\sum_{p=1}^{k}\delta_{12ip}\Delta Coc_{it-p} = 0$ no causality from CoC to EQ, $\sum_{p=1}^{k}\delta_{13ip}\Delta RQ_{it-p} = 0$ no causality from RQ to EQ, $\sum_{p=1}^{k}\delta_{14ip}\Delta RoL_{it-p} = 0$ tests for no causality from RoL to $\sum_{p=1}^{k}\delta_{15ip}\Delta VaA_{it-p} = 0$ tests for no causality from VaA to EQ. If the alternative hypothesis is accepted, causality exists. In the long-run causality test, the null hypothesis is $\phi_1\hat{\varepsilon}_{it-1} = 0$, which tests for the absence of causality from independent variables to EQ as a whole. In addition, the error correction coefficient also gives the correction time of the imbalances in the model. The panel Augmented mean group (AMG) parameter estimation method provides more robust results in both CSD and heterogeneous panels. AMG estimation is performed in two stages. In the first stage $\delta Y_{it} = \varphi_i + \delta_i\delta X_{it} + \theta_i f_t + \sum_{t=2}^{T}\pi_i\delta D_t$ and in the second stage $\hat{\delta}_{AMG} = N^{-1}\sum_{i=1}^{N}\hat{\delta}_i$ where φ_i is the constant term, Y_{it} and X_{it} are the dependent and independent variables, f_t the heterogeneous components, and $\hat{\delta}_{AMG}$ AMG are the estimators (Westerlund and Edgerton, 2008; Eberhardt and Bond, 2009). The AMG model aims to reveal the effect of each independent variables on the dependent variable.

As seen from Table 2, there is CSD for all variables used in the empirical analysis. The fact that countries within the same economic integration are neighboring each other with common institutional arrangements leads to CSD in carbon emissions. In model (1), there is CSD and the slope parameters for each country in the panel are heterogeneous. Carbon emissions clearly stand as an example of the negative externalities created by the global economy. High per capita income economies influence the environmental conditions of other economies (Nordhaus, 2007). In the case of the EU economy, common policy implementations brought by integration, such as the emissions trading system, make emission behaviors more interdependent (Ellerman and Joskow, 2008). According to Lambsdorff (2006), corruption practices may spread among countries that are more active in international trade. This phenomenon is also reflected in RQ. Policies required by economic integration and regulations made to gain a competitive

Table 1: Definitions

Data	Symbol	Source	Hypotheses
CO_2 emissions (kt)	EQ	WB	-
Control of corruption	CoC	WB	CoC negatively affects $lnCO_2$
Regulatory quality	RQ	WB	RQ negatively affects $lnCO_2$
Rule of law	RoL	WB	RQ negatively affects $lnCO_2$
Voice and accountability	VaA	WB	VaA negatively affects $lnCO_2$

WB show World Bank database

Table 2: CSD and homogeneity

CSD tests	EQ	CoC	RQ	RoL	VaA	Model CSD		Homogeneity	
CD_{lm}	117.671 (0.99)	283.352 (0.00)[a]	270.557 (0.00)[a]	281.959 (0.00)[a]	287.115 (0.00)[a]	LM	818.068 (0.00)[a]	$\tilde{\Delta}$	11.019 (0.00)[a]
CD_{lm}	−2.884 (0.00)[a]	6.075 (0.00)[a]	5.383 (0.00)[a]	6.000 (0.00)[a]	6.279 (0.00)[a]	CD_{lm}	17.628 (0.00)[a]	$\tilde{\Delta}_{adj}$	13.667 (0.00)[a]
CD	−3.429 (0.00)[a]	−3.499 (0.00)[a]	−3.484 (0.00)[a]	−3.389 (0.00)[a]	−3.571 (0.00)[a]	CD	20.588 (0.00)[a]		
LM_{adj}	−3.052 (0.00)[a]	2.433 (0.00)[a]	2.400 (0.00)[a]	3.364 (0.00)[a]	3.273 (0.00)[a]	LM_{adj}	17.145 (0.00)[a]		

[a]P<0.01

Table 3: Smith et al. (2004) "bootstrap" PUR

Levels	Constant		Constant and trend	
	Statistic	Bootstrap (P-value)	Statistic	Bootstrap (P-value)
EQ	−0.200	0.99	−2.184	0.42
CoC	−1.738	0.19	−2.198	0.37
RQ	−1.874	0.07[c]	−2.650	0.02[b]
RoL	−1.741	0.21	−2.455	0.15
VaA	−2.344	0.00[a]	−2.898	0.00[a]
First difference				
EQ	−3.784	0.00[a]	−3.863	0.00[a]
CoC	−3.896	0.00[a]	−3.990	0.00[a]
RQ	−4.237	0.00[a]	−4.257	0.00[a]
RoL	−4.238	0.00[a]	−4.243	0.00[a]
VaA	−4.745	0.00[a]	−4.846	0.00[a]

Probability values are obtained from 5000 bootstrap distribution.

advantage in trade may bring the regulatory pathways of economies closer together (Baldwin and Wyplosz, 2006). The rule of law forms the foundation of the institutional quality of economies. In economies that define a common legal framework, such as the EU, CSD will inevitably emerge. According to Inglehart and Welzel (2005), the effectiveness of civil society organizations and the media in one economy influences similar activities in other economies. As a result, CSD arises in the VaV variable. Within the EU-27, the production structure of each economy differs from one another. Since the share of sectors in total output varies, emission intensities also differ. In highly industrialized economies such as Germany and France, emission rates are different from those in service-oriented economies like Greece and Portugal. According to Hoel (2002), an economy with an energy-intensive production structure requires a stronger regulatory institutional quality, whereas this need is lower in economies dominated by the service sector. The institutional capacity in industrialized economies directs the production structure toward the use of alternative energy sources. Although common eco-political designs are established, economies may exhibit different behaviors in implementation. This factor differentiates the impact of institutional components on EQ. Finally, as Stern (2000) stated, countries with higher environmental sensitivity tend to have stronger institutional structures, making them more willing to reduce emissions.

The results given in the Table 3 shows that Smith et al. (2004) "bootstrap" PUR test differs from the others in that it obtains critical values using bootstrap. EQ, CoC, RoL variables are stationary at the first difference. RQ is stationary at 10% significance level in the model with constant and 5% significance level in the model with trend. VaA, on the other hand, does not have a UR problem at the level value. The presence of a UR in the level of EQ emissions indicates an increase in emissions, a deepening climate crisis, and rising environmental costs (IPCC, 2021; Stern, 2007). The underlying causes of this UR lie in market failure and negative externalities. Since markets do not account for the social welfare costs of increasing emissions, this highlights the regulatory role of the public sector. On the other hand, Raworth (2017) attributes the non-stationary nature of emissions to the failure of Neo-Classical growth models to consider rising environmental costs. This necessitates the incorporation of policy recommendations from circular economy models. As suggested by Acemoglu and Robinson (2012), in economies with weak institutional capacity, economic activities take place in an inefficient and unequal manner. This negatively affects economic actors' future expectations and productivity, ultimately leading to market failure. The stationarity of the RQ variable indicates that public authorities undertake regulatory activities to prevent unfair competition, correct market failures, and strengthen economic activities (World Bank, 2007). Meanwhile, the stationarity of the VaA variable signals that civil participation in democratic processes continues in a predictable manner.

As depicted in Table 4, in the SR, there is no causality from the factors determining IQ to EQ. However, in the LR, there is causality from the factors expressing IQ to EQ as a whole. Moreover, in this model where EQ is the dependent variable, the imbalances that arise in the SR rebalance in approximately 2.77 years. Alternative causality results are also obtained from Table 4. In the SR, there is causality from carbon emissions and RQ towards CoC, from carbon emissions and VaA towards RQ, from CoC and VaA towards RoL, and from carbon emissions and RQ towards VaA. The absence of short-term causality from institutional factors to EQ is consistent with economic theory's prediction that institutional change is a slow and gradual process. Acemoglu and Robinson (2012) argue that establishing institutional structures and modifying them over time according to changing conditions takes a long time, and that social norms, democratic processes, and participation do not immediately create a noticeable impact on economic activities. The short-term causality from EQ to CoC, as Bardhan (1997) pointed out, suggests that the complexity of environmental regulations and difficulties in their implementation may, in some cases, create opportunities for corruption. Olson (2010) also explains this by arguing that the role of public authority in resource allocation processes can lead to corruption. The causality from EQ and VaA to RQ can be explained through Stigler's (1971) regulatory theory, which posits that regulations are not only made for public welfare but also to serve the private interests of certain elites. A deterioration in EQ can increase environmental sensitivity among economic actors, which in turn can create pressure on public authorities to implement more effective regulations. The causality from CoC and VaA to RoL can be interpreted through the theory of complementarity. Institutional complementarity explains how systematically and effectively functioning institutions support each other (Hall and Soskice, 2001). The CoC and VaA parameters force public authorities to act in compliance with the legal framework. The short-term causality from EQ and RQ to VaA can be explained by the influence of public environmental awareness and democratic participation on environmental quality. Citizens who are environmentally conscious tend to demand more environmental regulations and expect public authorities to be more transparent and accountable in this regard. Finally, the long-term causality from institutional factors to EQ aligns with the predictions of institutional economics theory. According to North (1990) and Ostrom (1990), institutional structures influence the behavior and activities of economic actors over the long run. An effectively functioning institutional structure not only enhances the efficiency of environmental regulations but also ensures a more optimal allocation of resources.

According to Table 5, where the Augmented Mean Group (AMG) parameter estimation results are presented, the constant term is statistically significant at the 1% level of significance both for the whole panel and for the countries forming the panel. If the CoC variable increases by 1%, EQ decreases by 0.071% in Cyprus and

Table 4: SR (PVAR) and LR (PVECM) causality

Casuality direction	SR causality					LR causality
	Δ(EQ)	Δ(CoC)	Δ(RQ)	Δ(RoL)	Δ(VaA)	ECT(−1)
Δ(EQ)	-	7.405 (0.06)[c]	8.773 (0.03)[b]	5.663 (0.12)	6.384 (0.09)[c]	−0.361 [−6.916][a]
Δ(CoC)	3.224 (0.35)	-	1.565 (0.66)	11.703 (0.00)[a]	2.078 (0.55)	0.374 [2.285][a]
Δ(RQ)	4.574 (0.20)	7.027 (0.07)[c]	-	1.194 (0.75)	12.445 (0.00)[a]	0.322 [1.749][b]
Δ(RoL)	1.775 (0.62)	1.235 (0.74)	2.300 (0.51)	-	1.401 (0.70)	0.074 [0.529]
Δ(VaA)	1.416 (0.70)	4.247 (0.23)	7.933 (0.04)[b]	7.925 (0.04)[b]	-	0.231 [2.289][a]

[c]P<0.1, [b]P<0.05, [a]P<0.01, (): probability value, []: t statistics

Table 5: Augmented mean group (AMG) estimator

Countries	Constant	CoC	RQ	RoL	VaA
Austria	4.808 (0.00)[a]	0.045 (0.15)	−0.021 (0.80)	−0.033 (0.73)	0.040 (0.00)[a]
Belgium	4.751 (0.00[a]	0.037 (0.58)	0.017 (0.75)	−0.103 (0.11)	0.244 (0.00)[a]
Bulgaria	4.524 (0.00)[a]	−0.070 (0.21)	−0.001 (0.99)	−0.234 (0.13)	0.210 (0.15)
Croatia	4.290 (0.00)[a]	−0.026 (0.64)	0.043 (0.37)	−0.055 (0.33)	0.013 (0.90)
Cyprus	3.731 (0.00)[a]	−0.071 (0.02)[b]	0.099 (0.04)[b]	0.006 (0.88)	0.100 (0.19)
Czechia	5.092 (0.00)[a]	0.035 (0.03)[b]	−0.006 (0.52)	−0.033 (0.07)[c]	−0.003 (0.83)
Denmark	4.323 (0.00)[a]	0.339 (0.02)[b]	−0.163 (0.13)	0.021 (0.78)	−0.111 (0.00)[a]
Estonia	3.237 (0.00)[a]	−0.128 (0.46)	0.389 (0.22)	0.084 (0.66)	0.479 (0.47)
Finland	3.889 (0.00)[a]	0.271 (0.00)[a]	0.310 (0.00)[a]	−0.041 (0.73)	−0.128 (0.05)[c]
France	5.621 (0.00)[a]	0.013 (0.72)	−0.011 (0.65)	−0.095 (0.12)	0.050 (0.11)
Germany	5.597 (0.00)[a]	−0.002 (0.98)	0.036 (0.44)	0.068 (0.49)	0.132 (0.18)
Greece	4.952 (0.00)[a]	−0.028 (0.51)	0.044 (0.25)	0.048 (0.23)	−0.043 (0.00)[a]
Hungary	4.730 (0.00)[a]	0.079 (0.50)	−0.268 (0.00)[a]	0.194 (0.02)[b]	0.083 (0.17)
Ireland	4.426 (0.00)[a]	0.020 (0.48)	0.110 (0.00)[a]	−0.118 (0.00)[c]	0.132 (0.00)[a]
Italy	5.522 (0.00)[a]	0.034 (0.02)[b]	0.029 (0.19)	0.028 (0.22)	0.058 (0.07)[c]
Latvia	3.798 (0.00)[a]	−0.010 (0.81)	−0.004 (0.96)	0.100 (0.02)[b]	0.044 (0.67)
Lithuania	4.189 (0.00)[a]	−0.040 (0.53)	−0.141 (0.03)[b]	0.092 (0.04)[b]	−0.011 (0.95)
Luxembourg	3.708 (0.00)[a]	0.049 (0.12)	−0.086 (0.07)[c]	−0.011 (0.85)	0.258 (0.00)[c]
Malta	2.729 (0.00)[a]	−0.036 (0.77)	0.037 (0.76)	0.418 (0.03)[b]	0.043 (0.97)
Netherlands	5.193 (0.00)[a]	−0.060 (0.10)	0.024 (0.51)	0.085 (0.03)[b]	−0.028 (0.56)
Poland	5.480 (0.00)[a]	0.075 (0.00)[a]	0.061 (0.01)[b]	−0.028 (0.39)	−0.062 (0.12)
Portugal	4.566 (0.00)[a]	0.041 (0.70)	0.127 (0.02)[b]	0.058 (0.64)	0.058 (0.64)
Romania	4.958 (0.00)[a]	0.060 (0.46)	−0.047 (0.04)[b]	0.066 (0.07)[c]	0.066 (0.43)
Slovak Republic	4.783 (0.00)[a]	0.004 (0.98)	−0.047 (0.20)	−0.035 (0.47)	−0.169 (0.05)[c]
Slovenia	4.058 (0.00)[a]	−0.045 (0.31)	0.020 (0.41)	0.245 (0.00)[a]	−0.063 (0.50)
Spain	5.661 (0.00)[a]	−0.047 (0.06)[c]	0.108 (0.04)[b]	−0.063 (0.00)[a]	0.028 (0.69)
Sweden	4.578 (0.00)[a]	−0.038 (0.74)	−0.099 (0.32)	0.067 (0.56)	0.140 (0.32)
Panel	4.563 (0.00)[a]	0.018 (0.32)	0.020 (0.40)	0.013 (0.59)	0.054 (0.03)[b]

[c]P<0.1, [b]P<0.05, [a]P<0.01

0.047% in Spain. Conversely, if the CoC variable increases by 1%, EQ increases by 0.035% in Czechia, 0.336% in Denmark, 0.271% in Finland, 0.034% in Italy and 0.075% in Poland. If the variable regulatory quality increases by 1%, it increases by 0.099% in Cyprus, 0.310% in Finland, 0.11% in Ireland, 0.11% in 0.061% in Hungary, 0.127% in Portugal, 0.108% in Spain. On the other hand, if Regulatory quality increases by 1%, EQ decreases by 0.268% in Hungary, 0.141% in Lithuania, 0.086% in Luxembourg, 0.047% in Romania. If the RoL variable increases by 1%, it decreases by 0.191% in Hungary, 0.1% in Latvia, 0.092% in Lithuania, 0.418% in Malta, 0.418% in the Netherlands increases by 0.085%, 0.066% in Romania, 0.245% in Slovenia. On the other hand, if the RoL variable increases by 1%, EQ decreases by 0.033% in Czechia, 0.118% in Ireland and 0.063% in Spain. If the variable VaA increases by 1%, EQ increases by 0.04% in Austria, 0.244% in Belgium, 0.132% in Ireland, 0.058% in Italy and 0.258% in Luxembourg. Finally, if the VaA variable increases by 1%, EQ decreases by 0.111% in Denmark, 0.128% in Finland, 0.043% in Greece, 0.169% in Slovak Republic. The heterogeneous impact of CoC on EQ is explained through institutional economics as proposed by Ostrom (1990), North (1990), and Acemoglu and Robinson (2012). Firstly, the quality of the institutional structure influences the causes and consequences of economic activities. In economies with high corruption rates, it becomes more difficult for public institutions to comply with laws, thereby hindering the implementation of environmental policies. Therefore, Cyprus and Spain should persist decisively in their anti-corruption programs. Preventing corruption can have a positive impact on EQ by increasing the effectiveness of environmental regulations. However, according to Tiebout (1956), in economies where the institutional structure functions effectively and corruption rates are low, clearer environmental regulations are implemented. In such an economic environment, firms may prefer to relocate their production processes to other countries to reduce costs. In the economies of the Czech Republic, Denmark, Finland, Italy, and Poland, excessive regulations and bureaucracy should be streamlined, and measures should be taken to enhance firms' sensitivity to EQ. This effect can be explained by the public choice theory proposed by Buchanan and Tullock (1962).

According to public choice theory, public service providers may aim to maximize their own benefits. In economies where corruption is prevalent, public officials may seek to maximize their own interests instead of prioritizing environmental quality. If corruption rates decline, governments would aim to maximize social welfare rather than their own interests, thereby contributing positively to EQ. The impact of RQ on EQ is explained by the capture theory proposed by Stigler (1971). According to capture theory, regulations do not always serve to maximize public welfare but may instead benefit the country's elites. In the economies of Hungary, Lithuania, Luxembourg, and Romania, an increase in RQ positively impacts EQ. While high regulatory quality contributes positively to EQ, low regulatory quality has a negative impact. In the economies of Cyprus, Finland, Ireland, Portugal, and Spain, RQ should be improved. A participatory and transparent process should be followed in the preparation of regulations. On the other hand, the negative externalities resulting from the decline in EQ create a situation that markets would neither desire nor be willing to bear the cost of. The impact of RoL on EQ highlights the importance of contract enforcement and property rights. In economies with high RoL, contract terms and private property rights are more clearly defined. This encourages firms to adopt long-term investment strategies, increasing their sensitivity to EQ. However, if RoL is low, firms may resort to bribery to degrade environmental quality. In Hungary, Latvia, Lithuania, Malta, the Netherlands, Romania, and Slovenia, the RoL variable negatively affects EQ. In the Czech Republic, Ireland, and Spain, RoL contributes positively to EQ. In these economies, judicial independence and the legality of public administration actions must be consistently upheld. Public choice theory, democratization theories, and the impact of civil society on economic life explain the effect of VaA on EQ. It is quite clear that civil society's contribution to the democratization process makes public authorities more willing to enforce environmental regulations (Rodrik, 2011). In Austria, Belgium, Ireland, Italy, and Luxembourg, VaA has a negative impact on EQ. In these economies, democratic participation processes should be strengthened, and independent media should be supported. In Denmark, Finland, Greece, and Slovakia, VaA has a positive impact on EQ.

Since EQ largely depends on environmental policies determined by political institutions, it is necessary to reveal the importance of institutional structure in line with the economic growth target. Panel causality tests clearly show that regulations to improve institutional structure do not have an impact on EQ in the SR. Therefore, Austria, Belgium, Greece, Slovak Republic CoC, RQ, Regulations for RoL, Cyprus, Poland for RoL and VaA, Hungary, Lithuania, Romania for CoC and VaA, Latvia and Portugal for CoC, RQ and VaA, Malta and Netherlands for CoC, RQ and VaA. In the SR, there is bidirectional causality between VaA and RQ. Among institutional factors, RQ is considered to be the key variable. In economies with high values of RQ, the private sector is integrated into international markets. In economies where the foreign trade regime is liberal and the economy is in the development stage, emission-emitting investment goods are initially imported. Although capital inflows in the SR initially increase carbon emissions, they support EQ in the LR. According to Hunjra et al. (2020), there is a positive correlation between IQ and capital flows and financial development increases EQ. In Cyprus and Spain, the effect of CoC variable on EQ is obtained in line with the expectations of the theory. However, the economies of Czechia, Denmark, Finland, Italy and Poland open the door to empirical arguments that "*the pollution-haven hypothesis*" is valid. Fredreksson and Svensson (2003) argue that institutional structure has a positive effect on the enforcement of environmental laws in economies with low corruption rates, while it has a negative effect if the institutional structure is variable. According to Azimi and Rahman (2023), in economies with low accountability, political authority can create flexibility in laws to regulate EQ.

4. CONCLUDING REMARKS

Although the European Union includes some of the world's most developed countries, it faces environmental challenges. While the countries of the Union are prospering economically, they are struggling to maintain the prosperity of their various environmental features. In order to achieve the zero carbon target, the institutional structure needs support. In addition, the European Union, with its goal of sustainable economic growth, needs to identify institutional factors that can help mitigate ecological problems. This study analyzes the impact of regulatory quality, CoC, RoL, RQ, VaA variables on carbon emissions in European Union countries in the period 2002-2023. CoC, RoL, RQ variables are found to be affected by economic shocks. The possible effects of changes in institutional factors are not expected to have an immediate impact on macroeconomic aggregates. Therefore, the effects of these changes are expected to emerge within an average of 3 years at the earliest. On the other hand, institutional factors are also found to be interrelated in the SR. At this point, the most important institutional factor is regulatory quality. In economies with low carbon emissions, EQ has an impact on other institutional factors except for regulatory quality. This result indicates that in economies where sustainable economic growth is targeted, the institutional structure also adapts to this target. In the LR, it is clear that institutional structure has an impact on EQ.

Both the causality analyses and parameter estimate reveal that institutional factors have a significant impact on EQ, yet this effect varies across countries and involves complex dynamics. Findings indicate that while the effect of institutional parameters on EQ is limited in the short term, it becomes more pronounced in the long term. This suggests that institutional capacity adapts to economic realities more slowly and gradually. Improvements in institutional structures can enhance the effectiveness of environmental regulations, leading to long-term changes in economic activities. Institutional factors have no effect on EQ in Bulgaria, Croatia, Estonia, France, Germany, Sweden. Since Bulgaria, Croatia and Estonia are transition countries, they have not yet established sufficient institutional culture to reduce carbon emissions. In France and Germany, the high energy intensity brought about by economic size hinders efforts to reduce carbon emissions. The production process has an impact on capital-intensive sectors. Production mechanisms need to be developed to incentivize renewable energy production in these economies. In these countries, governments responding to the environmental demand of the average voter will help reduce environmental pollution. In Finland, Ireland and Spain, institutional factors have the greatest impact on EQ. On a country-by-country basis, CoC should be reinforced and supported in Cyprus and Spain, while in the Czech Republic, Denmark, Finland, Italy, and Poland, it should be addressed through different mechanisms. Regulatory quality should be improved in Cyprus, Finland, Ireland, Portugal, and Spain, and supported in Hungary, Lithuania, Luxembourg, and Romania. The rule of law should be strengthened in Hungary, Latvia, Lithuania, Malta, the Netherlands, Romania, and Slovenia. VaA should be enhanced in Denmark, Finland, Greece, and Slovakia.

Economic policy makers in transition economies need to reorganize the institutional structure to mitigate the effects of globalization that lead to market failures. For this, policymakers should prioritize institutional structure (especially RoL) in any agenda to reduce carbon emissions. In line with the sustainable development goals (SDGs), Bulgaria, Croatia and Estonia should reorganize their institutional structures and France, Germany and Sweden should look towards alternative sources of energy production. Ensuring the RoL, efforts to improve IQ, controlling corruption, and ensuring political stability can prevent environmental degradation by shifting energy production towards renewable energy generation. Since the transition economies within the European Union have not converged in terms of GDP, the public authority is expected to be more active in EQ as suggested by Gill et al. (2019). Because according to studies (Adams and Acheampong, 2019; Lv, 2017; Atsu and Adams, 2024), households' demand for clean environmental standards increases as the income level rises. To better understand the impact of IQ on EQ, future research could examine the impact of institutional structure on climate change mitigation in both developed and developing economies. The general findings of the study suggest that a comprehensive approach is needed to enhance the sustainability of EQ in EU economies. This approach should support institutional reforms, environmental policies, and democratic processes.

Accordingly, policy recommendations should be made in three contexts: (i) A policy framework should be adopted that incorporates the fundamental principles of institutional economics, such as combating corruption, increasing transparency in public spending, and ensuring regulatory sustainability. (ii) Within the framework of externality theory, policies should focus on pricing carbon emissions, shifting toward alternative energy sources, and integrating energy efficiency throughout the economy. (iii) In line with public choice theory, civil society organizations should be supported, and citizens' participation in democratic processes should be encouraged. Future research can explore several areas that would contribute to the economic literature. Within the framework of institutional complementarity, studies could examine the internal dynamics of institutional structures and how these dynamics influence the sustainability of environmental quality (Kerekes, 2011). Institutional structures' impact on sectoral emissions can be analyzed to provide sector-specific policy recommendations. Empirically, in line with the developments in econometric theory, the impact of IQ on EQ can be re-examined by determining the threshold value with panel threshold vector auto regression models in line with regimes. Because according to Güngör et al. (2021), there is bidirectional causality between institutional structure and EQ when domestic income is above a certain threshold. Lastly, the impact of resource efficiency initiatives on environmental quality can be explored, considering the recommendations of circular economy models.

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