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Carbon Emission Metrics in South-eastern Europe: Empirical Analysis of Trade and Economic Indicator Effects

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Abstract In recent years, the rising industrialization, trade, urbanization, and energy demand have affected the environment through carbon dioxide gas (CO_2) emission, which is a significant parameter known to impact air pollution directly. Consequently, many governments and international organizations conducted policies and regulations to address environmental degradation to pursue economic development. In Southeast European countries (SEE), the CO_2 emission calculated in metric tons per capita has increased by 19% in the last 20 years. This study examines the impact of trade development and further economic factors on the environmental indicator of CO_2 emission for the SEE region for the previous two decades. Data proceedings in this study are time series indicators for SEE, with an annual frequency of 2002 – 2021/2022. The statistical approach in the panel data model is used to find statistical significance, direct on-driven fixed factors, etc. CO_2 emission is investigated by factors such as trade openness, gross domestic product (GDP) growth, fossil fuel energy consumption, domestic credit to the private sector by banks, and urban population growth. The significance of trade openness and other economic variables on carbon emission is studied in this paper, focusing on formulating conclusions and recommendations to address mitigating these effects on environmental pollution.

Keywords Carbon Emission, Trade Openness, Economic Growth, Energy Consumption, SEE Countries

1. Introduction

Climate change is a big issue today and is a primary and long-term hazard to global ecosystems, economies, and societies. A key driver of this global phenomenon is carbon dioxide (CO_2) emission. As the scientific community endeavors to understand the full scope of factors influencing global carbon emissions, a spotlight has increasingly fallen upon the intricate ties binding economic factors to the rate and volume of CO_2 emission. From the Industrial Revolution to the digital age, economic development has historically been associated with increased energy consumption, much more from fossil fuels. The burning of coal, natural gas, and oil has powered the engines of growth but has continuously injected carbon dioxide into the atmosphere. Yet, the economic and environmental relationship is not strictly correlated. Economic structures, technological advancements, energy sources, policy frameworks, and societal consumption patterns converge in complex ways influence the carbon emissions of nations and regions [1].

In developed economies, for instance, while industrial growth may have initially led to spikes in carbon emissions, subsequent periods have often decoupled economic growth from emission rates due to technological innovations and transitions to service-based economies. In contrast, developing economies, many currently undergoing rapid industrialization, often grapple with the challenge of fueling growth without proportionally increasing their carbon emissions. Beyond the macro level, sector-specific economic activities, from transportation and housing to manufacturing and agriculture, contribute differently to carbon emissions. Adopting green technologies, sustainable practices, and policy incentives can significantly alter these sectoral impacts, emphasizing the nuanced relationship between economic factors and emissions.

Economic factors have often been cited as key contributors to the escalation or reduction of carbon outputs among the carbon emissions drivers. The disbalance between economic development and environmental sustainability has been debated for decades. Southeastern Europe, a region with countries at various stages of economic growth, provides a unique lens through which this relationship can be examined. While some countries have witnessed rapid industrialization, others still rely heavily on agriculture, offering varied perspectives on the economic environment. Additionally, as many of these countries seek greater integration into the global economy and European Union, the challenges and opportunities related to CO_2 emission and sustainable growth become even more pertinent.

Southeastern Europe, a region that has witnessed an average GDP growth of 3.5% annually over the past decade, is a testament to this trend. This commendable growth, however, comes at a cost. International Energy Agency (IEA) indicates that recent CO_2 emissions in Southeastern Europe have increased by 15% during the same period, suggesting a strong correlation between economic activities and the environment [2, 3]. The carbon emission profiles of these countries are closely tied to their histories. Post-communist states, for example, had energy-inefficient public entities that resulted in higher emissions. However, with the decline of such entities and the adoption of newer technologies, carbon emissions have been relatively reduced. Southeastern Europe (SEE) is a region characterized by diverse economies, each at different stages of development and transition. While some countries have made progress in integrating into the European Union, others still are not involved. This regional diversity is reflected in the energy consumption patterns and resulting carbon emissions. Energy consumption in SEE is driven by a mix of fossil fuels, hydroelectric power, and a growing but still limited reliance on renewables. Coal, especially in countries like Serbia, remains a significant energy source. Natural gas, imported primarily from Russia, is also a prominent energy source for many countries. Many countries in the region are dependent on energy imports. For instance, Greece relies heavily on oil imports, whereas countries like Bulgaria and North Macedonia depend on gas imports. With European integration, there's a push towards adopting more renewables. Countries like Croatia and Slovenia have made commendable progress in incorporating wind and solar energy into their grids.

Reducing carbon emissions in Southeastern Europe (SEE) poses unique challenges due to the region's diverse economic, political, and social contexts. At the same time, the overarching goal is global aspirations for a sustainable future. Some of the critical challenges faced by SEE in reducing CO_2 emissions:

Economic dependencies on high-emission industries: Many countries in the region, such as Serbia, have industries based on coal mining for energy and employment. Transitioning from such industries can have significant socio-economic implications, including unemployment and local economic downturns.

Inefficient infrastructure: Much of the energy infrastructure, especially in these post-communist countries, is outdated and ineffective. Replacing these systems requires significant capital investments, which some countries may struggle to secure.

Energy security concerns: The countries' energy security could be threatened by transitioning from fossil fuels without adequately developed alternative energy sources.

Inadequate investment in renewables: Many SEE countries struggle to attract investments in renewable projects, primarily due to regulatory uncertainties and less favorable economic conditions than Western Europe.

Political instability and policy inconsistencies: Political changes in the region lead to policy inconsistencies. Long-term commitments required for carbon reduction initiatives often suffer in such explosive environments.

This study explores how economic factors comprehensively influence CO_2 emissions in Southeastern European countries. The research offers actionable insights for policymakers, industry leaders, and society. Understanding the economic growth that can mitigate carbon emissions is critical in a generation where sustainable development is not just aspirational but imperative.

2. Literature Review

Countries across the world are exposed to a wide range of issues related to risks of environmental factors if sufficient measures are not adopted to maintain sustainable development. Carbon dioxide emissions (CO_2 emissions) are considered to be among the most significant greenhouse gases that play a role in amplifying global warming, contributing 75% to greenhouse gas volume [4]. Considering its long-lasting effects, many international bodies are making efforts to reduce CO_2 emissions on a large scale. A global agreement of the United Nations Framework Convention on Climate Change (UNFCCC) has been initiated to reduce greenhouse gases [5]. In spite of these efforts, challenges of sustainable development should address the deterioration of gas emissions affecting pollution by determining the relevant factors that, if not considered, might lead to policy failure [6]. Economic activities and CO_2 emissions seem to have a direct relation because an economy with a larger production volume would produce more substantial emissions, impelling rigorous environmental policy formation [7]. An increase in economic growth is associated with higher environmental pollution due to more consumption and production activities [8]. A vast amount of literature suggests that including further explanatory variables might improve the study of dynamic links among resource usage, environment, and economic growth [9 - 11]. In the nexus of economic growth and environmental quality, energy consumption has an immediate impact on economic growth, while its effect on the environment can be evidenced in the long run [12]. On the other hand, Kuznets curve (EKC) hypothesis shows the correlation between economic growth and CO_2 emissions is non-linear and inverted-U shaped, implying that economic growth is correlated with an increase in CO_2 emissions initially and it decreases once the economy matures [13].

Index decomposition and econometric techniques reveal that economic growth (measured by per capita GDP) and population growth are the primary drivers of emissions growth [14]. This study examines the factors influencing the rise of carbon dioxide emissions from 1980 to 2015 in over 100 countries. Upper-middle-income countries contributed over 70% of the global emission growth over the studied period. Fortunately, improved energy efficiency has curtailed emissions, preventing them from being 40% higher. Although renewable energy has significant growth recently, its contribution to reducing global emissions is limited due to its minor role in worldwide energy. Urban population growth affects CO_2 emissions [15]. Findings indicate that while a 1% increase in urban population results in about a 1% rise in total emissions, it also leads to a 0.3% drop in per capita emissions. Larger cities experience a more pronounced emissions increase than smaller ones. Factors driving these trends include population density, economic concentration, and energy intensity, with economic clustering boosting emissions and greater population density and energy efficiency reducing them.

Despite variations between countries, urbanization generally has a negative impact on carbon emissions in OECD high-income countries for a long period. The impact is relatively weak; for each percentage point increase in urbanization rate, CO_2 emissions per capita decrease by 0.015%, total CO_2 emissions decrease by 0.012%, and CO_2 emission intensity decrease by 0.009%. The study attributes this impact to factors like economic growth, energy efficiency, and changes in energy consumption [16]. The COVID-19 pandemic prompted researchers to analyze atmospheric carbon emissions as a natural experiment. Reviewing 121 publications from 2020-22 to understand the research focuses on sustainable low-carbon recovery post-COVID-19 [17]. Using both qualitative and quantitative methods, including the Kruskal Wallis Test for data analysis, it was found that researchers are mainly concerned with carbon emissions, their global impacts, and challenges in sustainable recovery. There's also an emphasis on the role of public policy, especially in the energy sector. The overarching theme is the significance of green recovery for future sustainability.

However, the expected impact on the environmental parameters can be positive or negative, explained respectively by simulation of the technological progress or the inefficiency of financial resource allocation [18, 19]. Other researchers [20], in their analysis of green recovery spending in France, Germany, and the UK, reveal significant differences. France leads in spending, the UK is considerably behind, and Germany invests notably in new technologies. These spending patterns are influenced by diverse strategic factors, from job creation to politics. The study concludes that pre-existing contexts play a substantial role in shaping green recovery plans, potentially limiting the realization of new opportunities. The literature review suggests that urbanization should also be included in the econometric model, as it plays a role in creating environmental problems such as industrial waste and air pollution. A focused study indicates the importance of international trade operations in two directions: a) increasing the efficiency of using scarce resources and encouraging the importation of cleaner technologies resulting in lower CO_2 emission; b) trade openness creates a depletion of natural resources resulting in higher levels of CO_2 emission [21].

Reference [22] presents an econometric model examining the UK's emissions over the past 150 years, highlighting the decline in coal use and the impact of technology improvements. The model accounts for significant shifts and anomalies, aiding policy impact detection and forecasting. To achieve the 2050 goal of an 80% reduction in emissions from 1970 levels, significant reductions across all CO_2 sources are needed, with the ultimate aim of nearly eliminating them for net-zero emissions. Their study [23], revealed that high polluters, both at the country and firm levels, negatively impact productivity growth when environmental policies change. Green support initially hinders total product growth factors but becomes beneficial over time. Market-based measures, like taxes, have a less detrimental effect on these growth factors for high polluters than non-market-based regulations like emission limits. In addition, a study [24] whose findings are interesting shows that tax income collection is irrelevant, while debt positively impacts CO_2 emissions reduction.

The study aims to analyze the impact of economic factors and financial development on the environmental indicator of CO_2 emission. Panel data for 13 Southeastern European countries (SEE) are analyzed in the 2001-2021/22 interval. The paper focuses on formulating conclusions and recommendations to address mitigating these effects on environmental pollution. This study consists of an elaborating theoretical background and literature review of the field, the methodology, and the econometric model proposed for the study, ending in results and discussions on the conclusions.

3. Research Methodology

This study assesses the effect of economic growth, energy consumption, financial development, trade openness, and the urban population on CO_2 emission. The sample consists of panel data from 13 South-Eastern Europe countries: Albania, Bulgaria, Bosnia and Herzegovina, Croatia, Cyprus, Greece, Moldova, Montenegro, North Macedonia, Romania, Serbia, Slovenia, and Turkey. Kosovo is not included in the study due to lack of data. Table 1 below shows that the analyzed data are time series 2001 – 2021/22 (with annual frequency), based on official publications of the World Bank.

Table 1. Variables used in the model

Variables	Description	Source
CO_2	CO_2 emissions (kg per 2010 US$ of GDP)	World Development Indicators (WDI)
GDP	GDP growth (annual %)	
EC	Fossil fuel energy consumption (% of total)	
TO	Trade openness (% of GDP)	
FIN	Domestic credit to private sector by banks (% of GDP)	
UR	Urban population growth (annual %)	

Source: Author's summary.

The panel unit root test identifies a specific ADF (augmented Dickey-Fuller test) for each of the cross-sections included in the model [25]. The hypotheses of this test are:

$$\Delta\hat{y}_{it} = \alpha y_{it-1} + \sum_{j=1}^{p_{it}} \beta_{ij} \Delta y_{it-j} + \varepsilon_{it} \tag{1}$$

Where y_{it} is the time series and with null hypothesis H_0: $\alpha_i = 0$ (and the alternative: $\alpha_i < 0$). p_{it} is the number of parameters to be evaluated (with cross-sectional and times). Null hypothesis H_0: $\alpha_i = 0$ shows the existence of all i's unit roots. In this equation, $i = 1, \ldots, N$ represents each of the thirteen SEE countries in the sample, while $t = 1, \ldots, T$ is a notation indicating the specific year between 2001 and 2021/22. The multiple linear regression model for panel data is used to perform the parameter's estimations, as explained below:

$$\begin{aligned} CO_{2it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 EC_{it} + \beta_3 TO_{it} + \\ + \beta_4 FIN_{it} + \beta_5 UR_{it} + \varepsilon_{it} \end{aligned} \tag{2}$$

This is a linear model form for panel data, where:

CO_{2it} = the dependent variable;

GDP_{it}, EC_{it}, TO_{it}, FIN_{it}, UR_{it} = the independent variables for *i*-countries and *t*-times respectively;

β_i = the model parameters, or coefficients of independent variables in the model, for $i = 1, 2, \ldots, 13$ (the change of the dependent variable ΔCO_{2it} is explained by these coefficients β_i, in "*ceteris paribus*").

ε_{it} = the error term, is the only variable that is not predicted and it must be stochastic.

The multiple linear regression model for panel data is conducted in this study [26], following basic assumptions of the Gauss-Markov Theorem:

First condition: the model must be of linear form related to the parameters β_i.

Second condition: the mathematical expectation of the error term must be $E(\varepsilon_{it}) = 0$.

Third condition: the model must have the error variance constant, i.e., $V(\varepsilon_{it}) = E(\varepsilon_{it}^2) = \sigma$.

Fourth condition: the model must not be correlated between error, $Cov(\varepsilon_{it}; \varepsilon_{jt}) = 0, i \neq j$.

Fifth condition: the model must not have multicollinearity, i.e., $Cov(x_{it}; x_{jt}) = 0, i \neq j$.

The parameter estimations are tested according to the fixed and random effects. Following identifying unit and time effects via the LR test, one should assess whether these impacts are fixed or result from coincidence. Within this context, the Hausman test is commonly conducted to choose among estimators. One of the most emphasized differences between fixed and random effects models is the correlation between unit impacts and independent variables. Random effects can be put forward as a more appropriate model if no such correlation exists. In the Hausman test, H0 = No correlation exists between explanatory variables and unit effects. After applying the Hausman test, the null hypothesis is accepted as related to the time. This implies that a random effect estimator is a better fit for the analysis of the phenomena in question, but the test figures out evidence to the contrary are related to cross-sections, which implies the fixed effect estimator by country.

4. Empirical Analysis and Findings

Descriptive statistics of standard deviation, correlation, and mean values of the model's parameters are given in Table 2 below. As the results show, the variables are relative indicators, where GDP growth and UR growth have higher coefficients of variation, respectively, related to the growth changes in the last decade in the Region (often with negative performance and economic crisis throughout the Region) as well as with increasing demographic changes of migration towards urban areas or emigration. However, according to the correlation coefficient, the variables are generally not strongly correlated, while the direction of correlation and statistical significance follows the logic explained by studies of this field with similar indicators in different regions.

Table 2. Descriptive statistics and correlation

	Correlation matrix						Descriptive stat.	
	CO_2	GDP	FIN	EC	TO	UR	Mean	St. Dev.
CO_2	1.0000						0.7034	0.4104
GDP	0.2294*	1.0000					3.0609	4.0231
FIN	-0.4276*	-0.3712*	1.0000				57.0835	48.8589
EC	0.2557*	0.0220	0.2813*	1.0000			81.1552	11.4778
TO	0.1519*	-0.0023	0.2911*	-0.2328*	1.0000		88.7021	27.3620
UR	-0.5131*	0.0623	0.1873*	-0.0422	-0.1998*	1.0000	0.4297	0.9940

Note: "*" $p < 0.05$ (statistical significance).

Source: Authors' calculations in E-views 12.

In order to build a stable model in time and space (according to the countries of the Region), the time series (variables) need to be stationary, so the tests of stationarity and their transformation into stationary with the first difference have been used. The information for the tests used and the result of assessments are summarized in Table 3 below:

Table 3. Panel unit root test

Variables	Level			First difference		
	Lm, Pesaran and Shin W-stat	ADF-Fisher, Chi-square	PP-Fisher, Chi-square	Lm, Pesaran and Shin W-stat	ADF-Fisher, Chi-square	PP-Fisher, Chi-square
CO_2	0.0272 (0.5108)	22.2309 (0.6760)	31.2238 (0.2200)	-4.9902 (0.0000)*	69.8483 (0.0000)*	181.9390 (0.0000)*
GDP	0.9371 (0.8257)	24.1729 (0.5661)	12.8894 (0.9849)	-2.8786 (0.0020)*	50.2992 (0.0029)*	99.3155 (0.0000)*
EC	2.2337 (0.9872)	20.0228 (0.7905)	41.2435 (0.0293)	-1.2166 (0.1119)	42.2318 (0.0232)	117.1230 (0.0000)*
TO	-0.7101 (0.2388)	30.6827 (0.2403)	22.6867 (0.6506)	-3.9713 (0.0000)*	60.7849 (0.0001)*	104.2030 (0.0000)*
FIN	0.4479 (0.6729)	20.8608 (0.7491)	21.8119 (0.6989)	-3.2779 (0.0005)*	55.0691 (0.0007)*	144.6310 (0.0000)*
UR	-5.7098 (0.0000)*	82.8487 (0.0000)*	62.3158 (0.0001)*	N/A	N/A	N/A

Note: "*" $p < 0.01$ (statistical significance). I(1) shows that the series is first-order integral (i.e., it is stationary with first difference, or symbol Δ).

Source: Authors' calculations in E-views 12.

According to the results in Table 3, all variables are stationary with the first difference except for the variable UR (urban population growth), which is stationary at the level. Therefore, the model for this study is based on panel data with the first difference. Consequently, the result of the evaluation of the model parameters interprets the relative change (elasticity) of the phenomenon studied in this paper. Table 4 below shows the tested model results for each variable of the model:

Table 4. Pool data model (*Dependent variable ΔCO_2*)

Independent variables:	Coefficient	Prob. (t-stat.)
β_0	-0.02312	0.0001*
ΔGDP_{it}	-0.0005	0.5398
ΔFIN_{it}	-0.0016	0.0258*
ΔEC_{it}	0.0133	0.0000*
ΔTO_{it}	0.0013	0.0080*
UR_{it}	0.0141	0.0134*
AR(2)	0.2466	0.0051*
Adjusted R^2	0.4378	
Prob. (F-stat.)	0.0000	

Note: “*” $p < 0.05$ (statistical significance) and AR(2) is error lag = 2.

Source: Authors’ calculations in E-views 12.

Empirical tests indicate that the model is statistically significant with a coefficient of determination R-squared equal to 43.78%. Therefore, for Southeast Europe countries, 43.78% of the CO_2 emission level is determined by the independent variables included in the model: ΔGDP growth (the marginal trend of economic growth); ΔEC (change of the energy consumption); ΔFIN (change of the domestic credit to private sector by banks as % of GDP); ΔTO (change of the trade openness as % of GDP); and UN (annual urban population growth in %). Due to the GDP growth series being stationary, the model has as an independent variable the first difference of GDP growth (i.e., the marginal trend of economic growth). The variable marginal GDP growth is not statistically significant in the model, which is explained by the very low absolute variation trend of this indicator compared to the variation of CO_2 emissions. During the study interval, countries in Southeast Europe experienced a low economic growth level and often economic decline, resulting in an insignificant correlation of GDP variable in the model”. Based on the correlation in table 2, GDP growth has a positive and statistically significant relationship with CO_2 emissions. We conclude that in these countries, GDP growth impacts the increase in CO_2 emissions but not the marginal rate of GDP growth. Based on the statistical tests estimated for the model, the given variables show a positive and statistically significant relation with the CO_2 emissions parameter:

Energy consumption (fossil fuel comprises coal, oil, petroleum, and natural gas products), EC: if energy consumption increases by 1%, it affects the increase in air pollution by higher CO_2 emissions with an average of 1.3 % at the Regional level. This relation is evident in previous studies as well because energy consumption (for vital and industrial needs) in any form results in more CO_2 emissions.

Trade openness, TO: an increase by 1% in open trade indicator affects air pollution by increasing CO_2 emissions by an average of 0.13% at the regional level. This effect can be explained by an increase in the level of foreign trade in the region, and industrialization in the countries, without fulfilling environmental standards in terms of levels of pollution and state control over the qualities of: means of transport, in storehouses, transport of gas and hydrocarbon lines, development of extractive or processing industries, etc.

Urban population growth, UR: if urban population growth is 1%, it is accompanied by an increase in air pollution (CO_2 emissions) by an average of 0.14% at the regional level. The increase in urbanization is accompanied by a rise of industrialized production to respond in time and amount to the growing need for urbanization. Also, an increase in transport traffic accompanies the concentration of population in urban areas, etc.

From the model results’ analysis, we identify a statistically significant and negative relationship between the development of the financial system, FIN, and CO_2 emissions. Therefore, if the financial system were to develop by 1% (through the level of crediting to the private sector), it would reduce air pollution by decreasing CO_2 emissions by an average of 0.16% at the regional level. During these two the last decades of study, the financial sector has played an important role in increasing the competition of businesses and technological advancement, and the private sector triggers the effectiveness of projects and innovations. The financing institutions (generally the financial sector) select these projects in perspective, enforcing the negative relationship between financial system development and CO_2 emissions, even in Southeast European countries.

Table 5. Analysis of the residual of the model

The test	Null hypothesis	Test result		Decision
		Statistic	Prob.	
Multicollinearity: VIF-test	H0: “model has not multicollinearity {Cov(ε_{it}; ε_{jt}) = 0 and Cov(x_{it}; x_{jt}) = 0 for each $i \neq j$}”	Absolute coefficient correlation < 0.5	p < 0.5	H0 is not rejected
Autocorrelation: LM-test (Breusch Pegan)	H0: “model has not autocorrelation {Cov(ε_{it}; ε_{it-p}) = 0 for p = 2.	Chi-squared = 96.8842	0.0725	H0 is not rejected
Heteroskedasticity: Wald-test	H0: “model has not heteroskedasticity {E(ε_{ti}) = constant}”	F-statistic = 1.0513	0.3904	H0 is not rejected
Normality test of ε_{ti}: Jarque-Bera-test	H0: “the residual {ε_{ti}} of the model has normality distribution”	Chi-squared = 168.24	0.0000	H0 is rejected

Source: The table summarizes the tests once they are proceeded in EViews 12 by the authors.

Table 6. Final model - fixed effects model (by countries) and random effects model (in time)

Dependent variable ΔCO_2	Fixed effects model		Random effects model	
Independent variables:	*Coefficient*	*Prob. (t-stat.)*	*Coefficient*	*Prob. (t-stat.)*
β_0	-0.0092	0.0903**	-0.0213	0.0004*
ΔGDP_{it}	-0.0008	0.3928	-0.0008	0.4251
ΔFIN_{it}	-0.0012	0.0140*	-0.0006	0.2527
ΔEC_{it}	0.0144	0.0000*	0.0130	0.0000*
ΔTO_{it}	0.0009	0.0662**	0.0008	0.1310
UR_{it}	-0.0085	0.3626	0.0120	0.0011*
AR(1)	-0.2419	0.0052*	---	---
Adjusted R^2	*0.4876*		*0.3899*	
Prob. (F-stat.)	*0.0000*		*0.0000*	

Note: “*” p < 0.05 and “**” p < 0.1 (statistical significance).

Source: Authors’ calculation in E-views 12.

This pool data model has successfully passed the main criteria of creating efficient models according to the Gauss-Markov theorem's main assumptions (Table 5), so the model is statistically reliable to explain the direction and strength of correlation of the variables.

To analyze and evaluate the robustness of the model, fixed effects and random effects models (Table 6) were tested according to the countries (SEE countries) and the time (2001 – 2021/22). The Hausman test favors the model with fixed effects by countries (chi-squared = 14.24 with p <0.0142). The same test favors the model with random effects with regard to time (chi-squared = 4.60 with p <0.4661).

Analyzing the model by time and countries, the results show that the time effect is not stable, therefore, over time, economic factors have had a changed effect on CO_2 emissions. Meanwhile, if we analyze the same model by South Eastern European countries, the model results show that this territorial effect is stable from one country to another, in the elasticity that economic factors impact the CO_2 emission levels. This stable effect by country is statistically significant for financial development, energy consumption, and trade (in the same way as in the pool data model). The results of econometric analysis emphasize the relevance of economic indicators in environmental parameters, indicating that common regional policies are needed to control CO_2 emissions in relation to these three economic factors of: financial development, energy consumption, and open trade. Policies that enhance economic growth accompanied by enforcement, regulations, and funding innovations to reduce emissions should be encouraged in Southeast Europe.

5. Conclusions

This study assesses the effect of economic growth, energy consumption, financial development, trade openness, and the urban population on CO_2 emission. The multiple linear regression model for panel data is used to perform the parameter’s estimations following basic assumptions of the Gauss-Markov Theorem. Empirical tests indicate that the model is statistically significant with a coefficient of determination R-squared 43.78%. Accordingly, 43.78% of the CO_2 emission level is determined by the macroeconomic, trade and urbanization factors of the Region. Based on the model estimations for the SEE countries: energy consumption, open trade and urban population growth have a positive significant relationship with the carbon emission indicator.

The findings show that if energy consumption increases by 1%, CO_2 emission will increase by 1.3% at the regional level, affecting the air pollution parameters. An increase by 1% in trade openness variable, results in 0.13% rise in CO_2 emission. Urban population growth is also expected to have a positive connection with CO_2 emission, as it results from the study its growth by 1% triggers the carbon emission by 0.14%. On the other hand, financial development shows a negative significant relationship with carbon emission, indicating that an increase by 1% in domestic credit to private sector by banks will impact CO_2 emission with a decrease by 0.16%.

GDP growth is not a statistically significant variable in the model, explained by its very low absolute value variation compared to the variation of CO_2 emission for the region. Analyzing the model by time and countries, the results show that the time effect is not stable, therefore over time economic factors have had a changed effect on CO_2 emissions. The analysis of the model by SEE countries points out that territorial effect is stable from one country to another, in the elasticity that economic factors impact the CO_2 emissions. Therefore, policies that enhance economic growth accompanied by enforcement, regulations and funding innovations to reduce emissions should be encouraged for the South Eastern Europe Region. Special attention should be given to environmental management, sustainable trade and economic growth, in academia and governmental level.

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