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ASSESSMENT OF SUSTAINABLE DEVELOPMENT IN SELECTED COUNTRIES OF SOUTHEAST EUROPE

Abstract

The purpose of this article is to examine the possibilities of sustainable development, as well as to assess the impact of certain environmental predictors on the real GDP increase of eight selected countries of Southeast Europe (Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, North Macedonia, Romania and Serbia) in the period from 2001 to 2020. Using the Least Squares Dummy Variable (LSDV) panel data method, the article shows that from the aspect of access to safely managed sanitation services, use of renewables and harmful CO_2 *emissions, economic development in these countries is not sustainable enough. At the same time, it is sustainable only from the perspective of agricultural methane emissions. Bearing this in mind, economic policy makers from these countries should work more intensively on intra-regional cooperation, as well as on complying with the recommendations from the SEE 2030 Strategy in guiding their countries towards sustainable development pathways.*

Key words: *sustainable development, Least Squares Dummy Variable (LSDV) approach, Southeast Europe (SEE),* CO_2 *emissions, environmental indicators*

JEL classification: *Q01, Q56, Q58*

ПРОЦЕНА ОДРЖИВОГ РАЗВОЈА У ОДАБРАНИМ ЗЕМЉАМА ЈУГОИСТОЧНЕ ЕВРОПЕ

Апстракт

Сврха овог чланка је испитивање могућности одрживог развоја, као и процена утицаја одређених еколошких предиктора на раст реалног БДП-а осам одабраних земаља југоисточне Европе (Албаније, Босне и Херцеговине, Бугарске, Хрватске, Грчке, Северне Македоније, Румуније и Србије) у периоду од 2001. до 2020. године. Применом панел методе Dummy варијабле најмањих квадрата, чланак показује да са аспекта приступа безбедно управљаним санитарним услугама, коришћења обновљивих извора и штетних емисија CO_2 *привредни развој ових земаља није довољно одржив, док је одржив само са аспекта емисија*

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метана у пољопривреди. Имајући то у виду, креатори економске политике би требало интензивније да раде на унутаррегионалној сарадњи, као и на поштовању препорука из Стратегије ЈИЕ 2030 у усмеравању својих земаља ка путањама одрживог развоја.

Кључне речи: *одрживи развој, ЛСДВ модел фиксних ефеката, југоисточна Европа (ЈИЕ), CO_2 емисије, еколошки показатељи*

Introduction

Although the concept of sustainable development officially appeared only in the second half of the 20th century, it is evident that its forms of expression existed for centuries before then. Even though this term can be described in many ways, its traditional and perhaps the most convincing definition comes from the Brundtland Report of 1987, which states that sustainable development is the type of development that meets the needs of the current generation, but not at the detriment and without compromising the needs of future ones (United Nations, 1987, pp. 2-151). This was the first strategic document that insisted on the integration of developmental and environmental issues, while the Report itself also introduced some of the basic principles of sustainable development, which are still relevant today. These postulates include the Polluter Pays Principle, the principle of universal resources, the principle of non-endangerment and non-exploitation of others, the principle of introducing environmental control measures, the use of renewable energy sources, and many others. Sustainable development, as a long-term interaction of social, economic, environmental and natural systems and a specific response to the complexity of global challenges, requires a carefully managed and gradual development policy (Filipović et al., 2004a, pp. 25-26).

As a somewhat vague concept that implies a symbiosis of environmental protection policies, developmental strategies and general social goals, sustainable development entails the integration of economic development and long-term conservation of natural resources (United Nations, 2015, p. 87). Based on the integration of ecological, economic and social goals, sustainable development has transformed over time into a kind of developmental paradigm that calls for economic progress and improvement of living standards, without jeopardizing the perspective of using resources and the earth's ecosystems (Mensah and Ricart Casadevall, 2019, p. 6). The importance of this concept is reflected in the efficient use of resources and environmental protection, mitigating the negative effects of climate change, maintaining the ecological balance, reducing poverty, encouraging education for all and social inclusion, with the ultimate goal of enabling long-term economic development (Tufaner and Türker, 2016, pp. 300-303). However, while the economic, social and environmental aims of sustainable development are well-founded in theory, the practice of many countries indicates that it is necessary to invest much more long-term efforts towards their achievement (Madžar, 2023, p. 286).

The South-Eastern Europe (SEE) represents a geographically, culturally and historically bounded entity (Muntilak Ivanović et al., 2009, p. 2080) made up of some member states and official candidate countries for membership in the European

Union (EU). The key concern of the SEE countries encompasses the imperative for managing environmental quality, as well as the promotion of the idea about sustainable development (United Nations Development Programme, 2007). In this regard, it is necessary to specify and monitor the state of sustainable development in these countries, as one of the prerequisites for EU membership, and in order to gain a clearer insight into the sustainability indicators of the region itself. This analysis traces some indicators of sustainable development in the Western Balkans countries (Albania, Bosnia and Herzegovina, North Macedonia and Serbia), but also more widely in Bulgaria, Croatia, Greece and Romania with the aim of obtaining a more comprehensive picture of this research problem.

The concept of sustainable development is incorporated into legislation and common EU policies, while the Sustainable Development Goals (SDGs) are included in the South East Europe 2030 Strategy itself, which was adopted at the Summit in Antalya in June 2021. The Strategy places an emphasis on improving the implementation of the SDGs, calling for stronger intra-regional cooperation of the SEE countries, but also for the adoption of comprehensive and consistent regional policies that would encourage their sustainable economic growth. At the same time, this strategic document in the form of particularly challenging problems in the region emphasizes youth unemployment, brain drain and depopulation, population aging, income inequalities, poverty, migration, climate change, pollution, sustainable energy supply, and limited financial resources (Ergezer et al., 2021, pp. 9-23). To put it in another way, these countries face similar economic, environmental and social constrains, while one of the possible solutions is the initiation of a green and digital transition that would accelerate their economic transformation (Österreichische Gesellschaft für Europapolitik, 2023). However, the main challenge of implementing this and similar global environmental documents is reflected in the maintenance of this vision, which would be closely connected to reality, and within which every action should lead to the creation of more sustainable and resilient societies (Filipović, 2024b, p. 54). In addition, the Western Balkans (WB) countries still base their economic activities on the prevailing brown industries, supported by sticky brown knowledge and skills, while the World Bank estimates that their path to green growth will not be easy at all (World Bank Group, 2021, p. 4). All of the mentioned above represents a good argument for paying more attention to the burning issues of sustainability in the SEE region.

Bearing in mind the stated importance of sustainable development, the purpose of this article is to examine the validity of the hypothesis about unsustainable development, as well as to assess the impact of certain infrastructural and environmental factors on sustainable development in selected SEE countries in the period from 2001 to 2020. Using the panel data Fixed Effects Model (FEM), the article assesses the sustainability of economic development on the example of the following eight analysed SEE countries: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, North Macedonia, Romania and Serbia. The article begins with the null hypothesis that economic development in these countries is not sustainable enough. The next section of this article provides a brief overview of relevant literature sources on the assessment of sustainable development in SEE countries, while the third one describes the sample and explains the materials and methods used in the research. The fourth section discusses the obtained results in detail, while the last one concludes the paper, giving some useful insights into the possible reasons for the perceived unsustainable development in the observed SEE countries and achieving the main goal of this research.

Literature review

Despite the vital importance of sustainable development for Southeast European countries, it is possible to observe a limited number of empirical researches devoted to the study of this important thematic field. The scientific contribution of this article stems from this fact, while it sheds light on certain infrastructural and environmental determinants of sustainable development in selected SEE countries. From the aspect of analysing environmental indicators and sustainable development in target countries, on a sample of 11 former Yugoslav and SEE countries, Muntilak Ivanović et al. (2009, p. 2079) compared their 38 relevant indicators from the social, economic, ecological and institutional subsystems with the same parameters for Germany, France and Greece as reference countries. They drew the inference that SEE countries, unlike developed EU countries, still have a fragile relationship between the sets of economic and environmental measures. This empirical research revealed high positive values of environmental indicators that point to potentially economically less developed SEE countries, concluding that they should make great efforts in directing their economic development, but without endangering their own valuable ecological potentials. Çelebioğlu (2012, pp. 477-485) applied Explanatory Spatial Data Analysis (ESDA), geovisualization, spatial autocorrelation and spatial modelling on a sample of 21 countries in Eastern and South-Eastern Europe in the period from 2000 to 2010. The author analysed the dynamics of the GDP per capita average growth rate for this period, as well as the values of the Human Development Index (HDI) and Sustainable HDI for 2010. He noticed that there was a significant gap in the level of development among the considered European countries, as well as that their location largely determined the level of these indicators, and thus of their economic and social development. The Local Indicators of Spatial Association (LISA) statistics also indicated the presence of significant local spatial autocorrelation, pointing to remarkable spatial heterogeneity that occurred in the form of two different spatial clusters, the first one with high and the second one with low values of the observed indicators.

Petrov et al. (2018) use clusters created by the hierarchical method on a sample of 10 countries of Southeast Europe. They consider 15 indicators, 13 of which represent indicators of economic well-being, social equality and environmental quality, while the remaining two metrics refer to the poverty gap and the Gini index. The authors conclude that the analysed countries can be classified into three separate clusters, while they differ from each other according to their socio-economic environment. Finally, the economic development occurs either as an enabler or as an obstacle to their social and environmental progress. Raszkowski and Bartniczak (2019) use the Synthetic Measures of Development (SMD) method on the example of 11 countries of Central and Eastern Europe in the period from 2010 to 2016 with the aim of assessing the level of their sustainable development. The authors conduct a comprehensive analysis of 66 global SDGs, as well as of driving and disincentive indicators that cover general areas relevant to meeting these goals. This empirical article concludes that the situation regarding sustainable development in the observed period has improved in the selected countries, although its condition is most favourable in the Czech Republic and Slovenia, moderate in Estonia, Hungary, Slovakia, Poland, Lithuania, Latvia and Croatia, while it is least conductive in Bulgaria and Romania.

In terms of the diagnosed relationship between environmental and economic development, Golušin et al. (2012, pp. 87-93) also analysed 20 different economic and environmental sustainable development indicators on an already mentioned repeated sample of 11 former Yugoslav and SEE countries. This research again pointed to a noticeable gap in the achieved degree of economic and environmental development among the SEE countries, on one hand, and Germany and France as the two most developed EU countries on the other hand. The article concludes that there is a clear direct connection between the degree of economic development and the threat to the environment, as well as that less developed SEE countries should invest large and wider efforts in their progress, but not at the expense of their own ecological prospects. Radovanović and Lior (2017) on the example of 10 SEE countries compare two basic scenarios: a) the traditional approach to assessing sustainable economic development, which is based on a high weighting of GDP-PPP variable with b) an alternative approach that assigns lower weights to GDP-PPP, but also higher weights to natural wealth and income equality (Gini coefficient). This research also included the consideration of Germany, France and Russia as the large non-EU country for the purpose of comparison. By using a set of 10 economic and 10 environmental indicators, they conclude that the SEE countries have the same, or even higher rankings of sustainability compared to the developed countries, as well as that developing countries that have relatively low greenhouse gas (GHG) emissions and energy use levels are in a more favourable position from the aspect of sustainable development.

Finally, from a policy approach point of view, Kutlača (2021) considers sustainable development in Albania, Bosnia and Herzegovina, North Macedonia, Montenegro and Serbia in the period from 2010 to 2019. The author emphasizes the achieved progress in energy efficiency, the use of renewable energy and the development of a smart specialization strategy in the selected countries. However, he also notes certain problems of WB countries, among which the brain drain, high youth unemployment rate, rampant corruption and underdeveloped financial systems stand out. In this sense, the author advocates for increased investment efforts in research and development, harmonization of their legal systems and institutional frameworks with those of the EU, commercialization of research systems, further encouragement of smart specialization strategies, as well as improvement of the scientific research work quality in scientific institutes and universities in adapting their national research systems to the needs and challenges of the new economy. On the other hand, the South East Europe (SEE) 2030 Strategy insists on the implementation of the 45 socio-economic UN Sustainable Development Goals in the SEE countries by fostering prosperity, empowering people and promoting peace and partnership (4Ps), all with the aim of eradicating poverty and reducing inequality, fostering social inclusion, strengthening marginalized groups, accelerating the green and digital transitions, preventing emigration flows and improving the overall quality of life of the population (Ergazer et. al, 2021, p. 27). These goals are particularly relevant in light of the accession of some of these countries to the EU and their Euro-Atlantic integration processes, as well as strengthening their resilience to global financial and economic crises, health challenges and other external shocks.

Sample description, materials and research methods

The aim of this article is to examine the hypothesis of unsustainable development on the example of the following eight selected countries of Southeast Europe: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, North Macedonia, Romania and Serbia, in the period from 2001 to 2020. The analysed sample initially consisted of 168 observations of a balanced panel, while the data used were derived from the UN SDGs and World Bank databases. With the aim of assessing the validity of the paradigm of unsustainable development in these countries, the paper examines the influence of relevant infrastructural, environmental and controlling economic predictors (Table 1) on the trend of real Gross domestic product (GDP) as one of the most frequently used indicators of sustainable growth in the scientific literature. The observed variables covered a number of different issues, especially in the domain of the United Nations goals SDG 6 (Clean Water and Sanitation), SDG 7 (Affordable and Clean Energy), SDG 8 (Decent Work and Economic Growth), and SDG 9 (Industry, Innovation and Infrastructure).

Table 1 Variables used in research

Sustainable development goal	Variable name	Variable code	Variable description	Variable type
	Real GDP level	GDP	Annual GDP values (in billions of 2015 constant US$)	Regressand
SDG 6	Sanitation services	SAN	The share of population using safely managed sanitation services (in %)	Predictor
SDG 7	Renewable energy	RWNE	Renewable energy consumption in total final energy consumption (in %)	Predictor
SDG 8	Unemployment rate	UNEM	The share of unemployed in total labour force (in %)	Control variable
SDG 9	CO_2 emissions	CO_2	Carbon dioxide (CO_2) emissions per capita (in metric tons)	Predictor
SDG 9	Agri methane emissions	AGRIME	Agricultural methane emissions (in thousands of metric tons of CO_2 equivalent)	Predictor
SDG 9	Industrial value added	IND	The share of manufacturing value added in GDP (in %)	Control variable

Source: UN SDGs (2023) and the World Bank (2023)

At first glance, there appears to be a considerable heterogeneity among the analysed sample countries, especially due to the fact that some of them have been the EU members for a long time (Bulgaria, Croatia, Greece and Romania), while the rest of the countries are still on their way to their full EU membership (Albania, Bosnia and Herzegovina, North Macedonia and Serbia). When it comes to the response variable of interest, huge discrepancies in the level of real GDP are noticed among the countries considered, with Greece as the leading country, followed by Romania, Bulgaria, Croatia, Serbia, Bosnia and Herzegovina, Albania and North Macedonia in last place. Regarding the unemployment rate, the observed countries showed slightly less fluctuations, with the maximum achieved value of this indicator in North Macedonia (37.3%), followed by Bosnia and Herzegovina (31.1%), Greece (27.5%) and Serbia (23%). On the other hand, in the period from 2000 to 2020, the lowest unemployment rates were obtained in Bulgaria (4.2%) and Romania (3.9%) as in the more developed countries from the sample. Finally, the perceived countries experienced smaller mutual differences in the share of industrial value added, with its maximum achieved value registered in Serbia (21.7%) and Romania (21.4%) and its lowest recorded value in Albania at the level of 4%.

In regard of the environmental variables of interest, the observed countries showed pronounced mutual discrepancies in access to safely managed sanitation services, with the highest value of this indicator in Greece at the level of 93%, Romania at 81.5% and Bulgaria at 70%. At the same time, Bosnia and Herzegovina and North Macedonia had the lowest share of the population with access to safely managed sanitary services, where these indicators amounted to around 19% and 13.6%, respectively. When it comes to CO_2 emissions, it is noted that the highest value of this indicator was achieved in Greece (9.4 mt per capita), followed by Serbia (7.7 mt per capita), Bulgaria (7 mt per capita) and Bosnia and Herzegovina (6.7 mt per capita). On the other hand, Albania, as a less developed sample country, had the lowest CO_2 emissions of only 1 metric ton per capita. Concerning the agricultural methane emissions, Romania and Serbia took the lead, while North Macedonia and Croatia experienced the lowest values of this indicator. Finally, it follows from the analysis that Albania (44.6%), Bosnia and Herzegovina (37.7%) and Croatia (33.6%) achieved the highest share of renewables in the total final energy consumption, while the surprising fact is that the opposite conclusion applies to Bulgaria (7.2%) and Greece (7.1%). The following Table 2 shows the summary results of the descriptive statistics of the indicators used in the analysis.

Table 2 Descriptive statistics of the used variables

Variables	Mean	Median	Maximum	Minimum	Stand. Dev.	Jarque-Bera	Prob.
Real GDP level	68.1893	39.6600	265.9700	6.0600	75.0560	44.6490*	0.0000
Sanitation services	45.2038	43.7350	93.3700	13.4700	23.2993	10.6185*	0.0049
Renewable energy	21.5108	20.0150	44.5800	7.1100	8.7128	10.1790	0.0062
Unemployment rate	16.4882	15.3300	37.2500	3.9000	8.4110	12.7916*	0.0017
CO_2 emissions	4.9375	4.7000	9.4000	1.0000	1.9253	0.2739	0.8720
Agri methane emissions	3195.619	2083.500	10225.000	769.000	2521.107	78.07948*	0.0000
Industrial value added	12.1474	12.2550	21.7300	4.0100	4.1592	1.8167	0.4032

**denotes statistical significance at the level of 5%*
Source: Authors' calculations

The article applies panel regression analysis with the aim of determining the relationship among the dependent variable Real GDP level and the observed explanatory variables. More precisely, the article uses the Fixed Effects Model (FEM) to identify the mentioned relations. The most general and simplest form of the Fixed Effects Model can be written as follows (Gujarati, 2012, pp. 293-298):

$$y_{it} = \alpha_i + \beta_i X_{it} + u_{it} \quad (1)$$

where y_{it} is the dependent variable estimated for each cross-sectional unit *i*, α_i is the intercept, X_{it} is the matrix of regression variables, β_i is the matrix of coefficients of explanatory variables, while u_{it} is the regression error term.

Taking into account Equation 1 and variable codes from Table 1, the considered research model can be written as follows:

$$\ln(GDP) = \alpha_i + \beta_1 SANit + \beta_2 RNWEit + \beta_3 UNEMit + \beta_4 CO_2 it + \beta_5 AGRIMEit + \beta_6 INDit + u_{it} \quad (2)$$

The statistical program used to analyse the panel data in the paper was the R programming language. The following software packages were used: plm, foreign, punitroots and lmtest.

Research results and discussion

The initial analysis included the calculation of the Variance Inflation Factor (VIF) for all observed independent variables in order to avoid the trap of multicollinearity between predictors. The values of the VIF indicator did not exceed the level of 2.85, indicating the absence of multicollinearity, as well as the possibility of continuing with the given research (Table 3).

Table 3 Collinearity statistics

Predictors	Tolerance	VIF
Sanitation services	0.438	2.285
Renewable energy	0.351	2.852
Unemployment rate	0.394	2.538
CO_2 emissions	0.358	2.790
Agri methane emissions	0.407	2.454
Industrial value added	0.398	2.512

Source: Authors' calculations

The article continued with the analysis of cross-sectional errors dependence across individually observed units *i*, that is, across analysed countries. For this purpose, the Pesaran CD cross-sectional dependence test was applied, which shows robust results even on small samples (Pesaran, 2004). The results of the applied Pesaran CD cross-sectional dependence test indicated the presence of cross-sectional dependence in all selected variables, with the exception of the Industrial value added indicator. The results of the cross-sectional dependence test are shown in the following Table 4.

Table 4 Pesaran CD cross-sectional dependence test results

Variables	Test statistic	Probability	Test diagnostics
Real GDP level	15.3471*	0.0000	Presence
Sanitation services	12.6231*	0.0000	Presence
Renewable energy	16.0950*	0.0000	Presence

Unemployment rate	10.4897*	0.0000	Presence
CO_2 emissions	5.0407*	0.0000	Presence
Agri methane emissions	16.9945*	0.0000	Presence
Industrial value added	1.5333	0.1252	Absence

** denotes statistical significance at the level of 5%*
Source: Authors' calculations

For this reason, the paper approached to the application of the second generation of panel data unit root tests, or more specifically to the use of the Covariate Augmented Dickey-Fuller (CADF) test, corrected for the effects of observed cross-correlational dependence, with the aim of determining the presence of stationarity of the observed variables. In this research, the CADF test was applied since it brings power gains, and it is appropriate for small size panels with macroeconomic data (Constantini and Lupi, 2011, pp. 1-41). The starting hypothesis of the CADF test is that all time series are stationary at the order of their first differences, while the alternative one is that at least one of them is not. After differentiating the variables and thus reducing the sample size from 168 to 160 observations, by using the CADF test, it was determined that all variables were stationary in their first differences at the level of statistical significance up to 5%. The only exception was the Real GDP level variable, which was stationary at the level of up to 10% (Table 5).

Table 5 Covariate Augmented Dickey-Fuller test results

Variables	**I(0)**			**I(1)**		
	None	**Drift**	**Trend**	**None**	**Drift**	**Trend**
Real GDP level	0.5165 (0.6973)	0.9252 (0.8226)	-2.2088* (0.0136)	-1.8044* (0.0356)	-2.8179* (0.0024)	-1.6063** (0.0541)
Sanitation services	-6.2006* (2.81e-10)	2.6279 (0.9957)	-1.1514 (0.1248)	-5.3153* (5.32e-08)	-5.6287* (9.07e-09)	-4.5513* (2.66e-06)
Renewable energy	-0.8470 (0.1985)	-0.4754 (0.3172)	1.9934 (0.9769)	-4.9344* (4.02e-07)	-4.1438* (1.70e-05)	-4.6209* (1.91e-06)
Unemployment rate	-2.9488* (0.0016)	3.6463 (0.9999)	3.5108 (0.9998)	-2.6686* (0.0038)	-2.4167* (0.0078)	-1.6562* (0.0488)
CO_2 emissions	0.7553 (0.775)	-1.8642* (0.0312)	-2.3506* (0.0094)	-3.1993* (0.0007)	-5.1046* (1.65e-07)	-6.166* (3.50e-10)
Agri methane emissions	-1.2356 (0.1083)	-4.481* (3.71e-06)	-4.5886* (2.23e-06)	-6.547* (2.93e-11)	-5.4972* (1.92e-08)	-4.2248* (1.19e-05
Industrial value added	2.037 (0.9792)	3.2131 (0.9993)	-2.1298* (0.0166)	-2.2653* (0.0118)	-6.7979* (5.30e-12)	-3.373* (0.0004)

**denotes statistical significance at the level of 5% and ** denotes statistical significance at the level of 10%*
Source: Authors' calculations

After this step, the article approached to the application of the F-test, the Lagrange multiplier test and the Hausman test with the aim of selecting the most appropriate panel data model (Table 6).

Table 6 The results of tests for selecting the most appropriate panel data model

Used tests	F-test	Breusch- Pagan Lagrange multiplier test	Hausman test
Test statistics	F = 3.7031*	Chisq = 7.7875*	Chisq = 24.9942*
Degrees of freedom	df1 = 7, df2 = 146	1	6
P-value	0.0010	0.0053	0.0003

* *denotes statistical significance at the level of 1%*
Source: Authors' calculations

Diagnostics of the conducted tests from the previous Table 6 indicated that the Fixed Effects Model (FEM) appeared as the best choice. The following Table 7 represents the results of post hoc tests for the evaluation of serial correlation, cross-sectional dependence and heteroskedasticity of the selected FEM model.

Table 7 The results of post hoc tests of the chosen Fixed Effects Model

Used tests	Breusch- Godfrey/ Wooldridge test	Pesaran CD test	Modified Wald test for groupwise heteroskedasticity
Test statistics	Chisq = 45.456*	z = 9.7212*	Chisq = 37.75*
Degrees of freedom	20	-	8
P-value	0.0009	0.0000	0.0000

* *denotes statistical significance at the level of 1%*
Source: Authors' calculations

The results of the Breusch-Godfrey/Wooldridge test for serial correlation showed that there was serial correlation in the model. The results of the Pesaran CD test for cross-sectional dependence confirmed the presence of cross-sectional dependence in the model. Finally, the results of the conducted Modified Wald test for groupwise heteroskedasticity indicated the presence of the heteroskedasticity problem in the selected model.

The following Table 8 presents the comparative results of the conducted panel regression analysis. The authors opted for conducting the panel regression analysis on the variables that were transformed by their first differentiation, bearing in mind the previously mentioned results of the panel unit root test from Table 5. Although the results of the conducted Hausman test clearly favoured the application of the Fixed Effects Model, the succeeding Table 7 provides a comparative overview of the following three competitive models` results: a) the Pooled model, b) the Feasible Generalized Least Squares (FGLS) model and of the most appropriate c) the Least Squares Dummy Variable (LSDV) model outcomes. In addition, it is important to note that the standard errors of the chosen and presented LSDV Fixed Effects Model were corrected for the effects of the observed autocorrelation, cross-sectional dependence and heteroskedasticity.

Table 8 The results of the Polled, FGLS and LSDV panel data regression models

Variables and test diagnostics	Pooled model	FGLS model	LSDV model
Constant	0.0236* (0.0011)	0.0253* (0.0033)	0.0296* (0.0055)
Sanitation services	-0.0033** (0.0013)	-0.0072** (0.0035)	-0.0151** (0.0062)
Renewable energy	-0.0003 (0.0004)	-0.0001 (0.0006)	-0.0005 (0.0013)
Unemployment rate	-0.0065* (0.0005)	-0.0051* (0.0008)	-0.0064* (0.0018)
CO_2 emissions	0.0440* (0.0030)	0.0275* (0.0047)	0.0382* (0.0084)
Agri methane emissions	-1.52E-05** (6.29E-06)	-1.85E-05 (1.18E-05)	-8.97E-07 (2.13E-05)
Industrial value added	-0.0076* (0.0014)	-0.0047*** (0.0024)	-0.0085** (0.0041)
Standard error of regression	0.0300	0.9861	0.0288
Residual sum of squares	0.9990	141.9712	0.1212
R-squared	0.3438	0.6048	0.4427
Adj. R-squared	0.3402	0.5697	0.3931
F-statistic	97.1737*	17.1905*	8.9217*
P-value of F-statistic	0.0000	0.0000	0.0000
Durbin-Watson statistic	1.4445	1.5155	1.5249

** denotes statistical significance at the level of 1%, ** denotes statistical significance at the level of 5%, while *** denotes statistical significance at the level of 10%, standard errors in parentheses*

Source: Authors' calculations

The results of the selected LSDV model indicated a statistically significant relationship among the response variable ln(GDP) and the following explanatory variables: Sanitation services, Unemployment rate, CO_2 emissions (in mt pc), and Industrial value added. The only exceptions were the Renewable energy and the Agricultural methane emissions variables, which did not generate statistically significant results. Furthermore, a negative relationship was observed among the variables ln(GDP) and Sanitation services, Renewable energy, Unemployment rate, Agri methane emissions, and Industrial value added, while there was a positive relationship between the dependent variable ln(GDP) and CO_2 emissions (in mt pc). Expressed in relation to the dependent variable ln(GDP), the obtained value of the CO_2 emissions β coefficient amounted to 0.0382. The Adjusted coefficient of determination (Adjusted R-squared) of the proposed model was about 0.39, which means that the model explained about 39% of the variations of the dependent variable ln(GDP) for the observed countries. In addition, the F-statistic value of 8.9217 was statistically significant at the level of $p=0.0000<0.001$, implying that all predictors jointly contributed to the real GDP and that it was a well-fitted model. Finally, a correct value of the Durbin-Watson statistic of 1.5249 showed the absence of autocorrelation from the selected model (Doryab and Salehi, 2018, p. 103), also suggesting that it was a valid model.

First of all, these results indicate that the infrastructure in the observed countries expressed by access to safely managed sanitary services probably does not follow the needs of their real GDP increase, which is why one can conclude that from this aspect the economic development of the observed SEE countries is not sustainable enough. At the same time, sustainable and high-quality infrastructure is of key importance for economic development since it brings numerous economic, social and environmental benefits and supports economic growth by enabling the availability of fundamental services and improving economic opportunities for all economic subjects (OECD, 2023). The development of such infrastructure is of vital importance for every economy since it is more protected from climate risks and it contributes to a better quality of life, superior production processes, and higher returns on investments (Beksultanova et al., 2021). Among other things, sustainable infrastructure contributes to greater employment opportunities, migratory movements of workers and companies' decisions about their investment locations (Ahmad, 2021). Although upgrading and improving existing infrastructural solutions can be a challenge for the development of any contemporary society and the well-being of its citizens, better management of infrastructural systems, greater investments and the establishment of smart and digital infrastructure represent key steps in their direction towards sustainable development (Mouratidis, 2021). All of the above leads to the conclusion that SEE countries will have to work more decisively on developing their sustainable infrastructure in order to be able to catch up with the more developed part of the world.

Furthermore, the negative relationship between the use of renewables and the level of real GDP also indicates the unsustainability of their development, since their economic development is accompanied by decreasing use of renewable energy sources. The results of the conducted analysis also indicated that parallel to their real GDP increase, harmful CO_2 emissions also rise, based on which it can be concluded that in the sample countries economic development is not sustainable even from this aspect. In contrast to the expected effects of the Unemployment rate variable, the Industrial value added also quite unexpectedly showed a negative statistical relationship with the level of real GDP. These findings probably arose as a result of the fact that this article analyzes relatively underdeveloped SEE countries in relation to the EU average. At the same time, the other part of the analysed countries bases their development to the greatest extent on services, tourism and trade, while some of them also base it on agriculture. Finally, of all observed environmental predictors, only agricultural methane emissions yielded the expected negative relationship with the dependent variable real GDP. It should also be noted that the observed environmental variable (CO_2 emissions) is treated as an expression of consumption, i.e. the demand side factor. In other words, this indicator is perceived in the light of the production factors consumption influence on the production process itself and on energy production (thermal power plants and population consumption for everyday needs using wood and coal). In this way, the results of this conducted research fit quite well with the findings of other considered authors (Muntilak Ivanović et al., 2009; Golušin et al., 2012; Çelebioğlu, 2012; Radovanović and Lior, 2017; Petrov et al., 2018) on the negative relationship between economic growth and environmental protection expressed by environmental indicators trend, and therefore on the unsustainability of economic development in SEE countries.

Conclusion

The purpose of this article was to examine the validity of the sustainable development hypothesis, as well as to assess the impact of selected infrastructural and environmental indicators on the sustainable development in the observed SEE countries in the period from 2001 to 2020. More precisely, the analysis included an assessment of the feasibility of the sustainable development paradigm on the example of Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, North Macedonia, Romania and Serbia. Using the LSDV approach in evaluating the panel data, the article concluded that in these SEE countries, from the aspect of access to safely managed sanitary services, the use of renewable energy sources and harmful CO_2 emissions, their economic development was unsustainable. On the other hand, only the variable related to agricultural methane emissions showed the expected and therefore negative relationship with real GDP increase, indicating that they decreased along with the increase in the real GDP level. These findings confirmed the initial paper's hypothesis on the unsustainability of economic development in the given countries, with the exception of observed emissions of agricultural methane.

The obtained results are very significant since they indicate that the analysed countries clearly lag behind the developed ones in the context of sustainable development parameters. The findings also indicate that these SEE countries should invest much more effort in the future to promote their sustainable developmental paths, especially taking into account the fact that unsustainable development can lead to a series of negative externalities. In this sense, this article is especially instructive to public policy and decision makers, but also to researchers, scientists and a wider readership interested in encouraging sustainable development in the region of Southeast Europe. The objective limitation of this article relates to the availability of data used for the observed SEE countries, as well as to the fact that the analysis considered eight countries, a larger number of which could somewhat change the results obtained. In addition, this research is also limited by the impact of infrastructural, environmental and economic factors on the sustainable economic development of the countries considered. Therefore, possible future research directions of these important issues could focus on the investigating the influence of social factors and soft infrastructure such as health care, education, institutional development, rule of law, political instability, quality of financial institutions and prevailing inequalities on the sustainable development of the observed SEE countries.

The wider implications of this research are related to the fact that it contributes to the expansion of the stock of theoretical and empirical knowledge of this area, which makes the obtained results significant for decision and policy makers, researchers and the concerned wider public. The obtained findings indicate that in the future, decision and policy makers should more seriously consider the principles and recommendations from the SEE 2030 strategy in order to encourage intra-regional cooperation, develop sustainable infrastructure and thus finally guide their countries towards pathways of sustainable growth and development. This particularly applies to the improvements of elementary sanitary infrastructure, transport networks that prevent access to markets, increasing the resilience of educational systems and health infrastructure to disasters, better use of existing financial facilities, encouraging further investments in research, development and innovation, developing ICT and digital broadband infrastructure, strengthening local infrastructure for the use of renewables, encouraging social protection policies, etc.

On a more concrete level, in terms of improved management of sanitation service supply, these countries need to educate and raise awareness among the population, implement strong sanitation management systems, improve water purification systems, work on the introduction, improvement and development of sustainable sanitation infrastructure, promote clean water practices, mobilize drivers for maintaining of public spaces and improve cooperation with local communities, all in accordance with Integrated Water Resource Management approach. This holistic approach promotes the safe use of water resources, the careful use of wastewater and the savings in water use for household and agricultural needs (Thevenon, 2020, p. 2). On the other hand, in terms of using renewables and reducing harmful CO_2 emissions, these countries need to work more seriously on promoting and developing stable and predictable policies for sustainable development, energy independence, energy security and a green transition through focusing on more intensive use of renewables. In this regard, investments in the construction of new clean energy capacities, the modernization of existing energy infrastructure and the introduction of innovative technologies should be intensified with the aim of increasing the potential of renewable energy resources and minimizing harmful CO_2 emissions. The aforementioned efforts could be supplemented by the increased use of pellets and biomass, as well as by encouraging the production of electricity and heat from environmentally friendly and renewable sources (Mykoliuk and Bobrovnyk, 2019, p. 69), with reduced pollution, and therefore by enhancing more sustainable development of the observed countries.

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