ECONOMIC THEMES (2018) 56(2): 253-268

http://www.economic-themes.com/

EXPLORING ECONOMIC GROWTH AND ENVIRONMENT NEXUS IN NINE SOUTHEASTERN EUROPEAN COUNTRIES

Petar Mitić

Institute of Economic Sciences, Belgrade, Republic of Serbia

✉ *petar.mitic@ien.bg.ac.rs*

Slobodan Cvetanović

University of Niš, Faculty of Economics, Niš, Republic of Serbia

✉ *slobodan.cvetanovic@eknfak.ni.ac.rs*

UDC 338.1+502/ 504(497)

Original scientific paper

Abstract: This paper investigates the interdependence between environmental degradation (CO2 emissions) and economic growth (GDP per capita) in nine SEE countries over the period 1992 – 2016. The results of Granger causality testing indicate that in the short run there is a positive bidirectional causal relationship between CO2 emissions and GDP per capita, but in the long run, there is causality running just from GDP per capita to CO2 emissions, with the 2.0279% speed of adjustment. In pursuit of adequate policy measures, SEE countries need to work on inclusion of non-EU countries into European Union's Emissions Trading Scheme, further developing carbon taxation policies and using renewable energy sources on a larger scale.

Received: 13.06.2018
Accepted: 21.06.2018

Keywords: CO2 emissions, GDP per capita, environmental degradation, economic growth, Granger causality testing, panel data

JEL classification: Q50, R11, O44, C33

1. Introduction

Over the past few decades, there has been a significant increase in economic activity worldwide. One of the undesired effects of this increase is the rise of CO_2 emissions (Abdullah, 2015), as well as other environmental pollutants. A modern economic system cannot exist without a functional ecological system as a source of

---

This paper is a part of research projects numbers 47009 (European integrations and social and economic changes in Serbian economy on the way to the EU) and 179015 (Challenges and prospects of structural changes in Serbia: Strategic directions for economic development and harmonization with EU requirements), financed by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

natural resources, on the one hand, and as a recipient of waste materials, on the other (Stanojević, Mitić & Rakić, 2013). Authors such as Borhan, Ahmed & Hitam (2012) list the following as key factors of environmental degradation: "industrialization, transport, population, poverty, soil erosion, congestion and traffic, exploitation of open access resource due to ill-defined property rights, etc." Contemporary policy trends are going in the direction of developing and supporting green growth, i.e. investing in activities that are in function of income growth and employment, but are still in high compliance with environmental requirements (Jeločnik et al., 2016).

Research on the interdependence of harmful emissions and economic growth is one of the most important empirical relationships tested in the literature of the environmental economics (Narayan, & Narayan, 2010). The relationship between pollution and economic growth has been explored for various pollutants, but "due to the release of enormous amounts of CO_2 in the combustion of fossil energy, CO_2 emissions are classified as one of the main driving forces behind global warming today" (Friedl & Getzner, 2003). These authors further elaborate that GHG emissions are rising despite joint efforts enforced by international agreements such as the Kyoto Protocol (Friedl & Getzner, 2003) and the currently effective Paris Agreement. The Paris Agreement, signed by all SEE countries, recognises that deep reductions in global emissions are required in order to achieve the ultimate objective of the Convention (unfccc.int, 2018). However, the Paris Agreement recognises that none of the world's leading powers can be compelled to drastically reduce harmful emissions. However, it introduces a system based on the country's promise to reduce harmful emissions, thus creating an international system of responsibility for climate change. "In this sense, the Paris climate summit marks the beginning of a new era in international climate policy, which offers the chance of more durable international cooperation" (Falkner, 2016).

It is precisely the analysis of the relationship between the quality of the environment and economic growth that allows the creators of different policies to understand the interplay of these variables, and, accordingly, bring about quality information-based decisions. The concept of environmental protection is integrated into strategic documents of almost all countries of the world regardless of the degree of their development (Domazet & Jovanović, 2016).

1.1. SEE countries

In the last period SEE countries experienced and some are still going through the transition process. Out of the nine countries that are the subject of this process, five (Bulgaria, Croatia, Greece, Romania and Slovenia) are EU members, three are candidates (Albania, Serbia and Macedonia), while only Bosnia and Herzegovina is a potential candidate for EU accession.

According to Kalaš, Mirović & Pjanić (2017), it is necessary to improve productivity and adapt production structure with a high level of finalization and technology in the SEE countries. Also, they state that "the permanent involvement of new technical content and innovation, as well as modern management is a key prerequisite for potential growth of the economy" (Kalaš, Mirović & Pjanić, 2017). All SEE countries recorded positive rates of economic growth before the global economic crisis, primarily as a result of not only rapid expansion of loans for investment and consumption, but also a significant inflow of foreign direct investment. On the other hand, the problem that all SEE countries have is a significant share of the shadow economy in their GDP.

All SEE countries that are candidates and potential candidates for joining the EU are small economies, which are still insufficiently aligned with European and international standards. These countries have inadequate infrastructure and insufficient credit support.

When analysing the economic structure of all SEE countries by sector, there is substantial participation in mining, industry, agriculture and forestry - sectors that are considered significant polluters of the environment. The service sector, on the other hand, is less developed. The national resources of all countries are significant, especially those used in the production of agricultural products, grapes and wines, fruits and vegetables. Great chances are in the development of livestock breeding as well. In addition to agriculture, it is considered that black metallurgy and the chemical industry are developmental opportunities of SEE countries.

1.2. Literature Review

Although there was significant previous research on interdependence (Manne & Richels (1990); Ogawa (1991)), one of the first papers examining the relationship between economic growth and environmental quality using complex econometric methodology was done by Shafik & Bandyopadhyay (1992). Their paper found a significant relationship between economic growth and environmental quality. It stated that the income had a significant effect on the quality of the environment, but as incomes rose, most environmental indicators deteriorated initially with a tendency to improve with the rise of income levels. Thereafter, two currents of research were generally apparent: the one investigating the relationship between the economy and the environment in individual countries and the other dealing with this relationship in groups of countries. As the subject of this paper is a group of SEE countries, the remaining literature review provides a concise overview of the works and methodologies related to groups of countries.

Martínez-Zarzoso & Bengochea-Morancho (2004) investigated the CO_2 - GDP relationship for 22 OECD countries in the period 1975-1998, using pooled mean group estimation. The results indicate that a decline in CO_2 emissions can be expected to a certain level in rising income, while at higher income levels the emission increase can be expected. The relationship between CO_2 emissions, electricity consumption and economic growth for five ASEAN countries over the period 1980–2006 was analysed by Lean &Smyth (2010).Using a panel VECM, they conclude that there is a statistically significant interdependence between emissions and economic growth. Arouri et al. (2012) analysed the relationship between CO_2 emissions, energy consumption and real GDP for 12 MENA countries over the period 1981–2005. They concluded that real GDP exhibited a quadratic relationship with CO_2 emissions for the MENA region. Azam (2016) investigated the impact of environmental degradation by CO_2 emissions on the economic growth of 11 Asian countries over the period 1990-2011. The empirical result reveals that CO_2 emissions are negatively related to economic growth. Mitić, Munitlak Ivanović & Zdravković (2017) analysed the relationship between real GDP and CO_2 emissions for 17 transitional economies from 1997 to 2014. Using DOLS and FMOLS approaches, they prove the existence of a statistically significant long-run cointegrating relationship between CO_2 emissions and real GDP. Similar research on the relationship between environmental degradation and economic growth can be found in Tamazian, Chousa & Vadlamannati, (2009), Al-Mulali & Sab, (2012), Sebri & Ben-Salha, (2014), Salahuddin & Gow, (2014), Shahbaz et al., (2015), Kasman & Duman, (2015), etc.

2. Data

The variables used for this research are GDP per capita (GDPpc) and CO_2 emissions (CO_2). Annual data were collected over the period 1992-2016, for nine Southeastern European countries: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Romania, Serbia, Slovenia and FYR Macedonia. Montenegro was excluded from the research due to the lack of available data necessary for the analysis.

Data for GDPpc, measured in US dollars at constant 2005 prices, were taken from the United Nations Conference on Trade and Development (unctadstat.unctad.org, 2017). GDP is a macroeconomic indicator expressed in monetary units and represents the value of final goods and services produced in a particular country in one year. GDP per capita is the gross domestic product divided by the number of inhabitants. The most common measure of economic growth is precisely GDP per capita, and that is why it has been selected as a variable for the purposes of this research.

The data on territorial CO_2 emissions in millions of tonnes are taken from the Global Carbon Atlas (Boden, Andres & Marland, 2017). Territorial emissions mean that CO_2 emissions are attributed to the country in which they are physically present. These data refer to CO_2 emissions from oxidation of coal, oil and gas, combustion of exhaust gas and CO_2 ventilation in the oil and gas industry that converts methane into CO_2 and chemical reactions in cement production. These emissions are taken as a measure of environmental degradation since CO_2 comprises the largest share of greenhouse gases, which directly contributes to global warming and climate change.

Table 1 provides a statistical summary of the variable values used in the research. Out of all SEE countries, Romania has the highest mean of CO_2 emissions (99.820), followed closely by Greece (95.963). On the other hand, Albania has the lowest mean of CO_2 emissions (3.6566). Consequently, Romania has maximum values of CO_2 emissions (131.23), followed by Greece (114.13), whereas Albania has minimal value of CO_2 emissions (1.5425). Additionally, when the largest variation in CO_2 emissions is considered, Romania is in the lead (18.363). When GDP per capita is concerned, Greece has the highest mean (19394), followed by Slovenia (16640). The lowest values of GDP per capita mean is recorded in Bosnia and Herzegovina (2535.9), closely followed by Albania (2584.5). Accordingly, Greece has maximum values of GDP per capita (24288), followed by Romania (20891), whereas Bosnia and Herzegovina has the lowest minimum values (565.91). Furthermore, Slovenia shows the largest variation in GDP per capita (3138).

Table 1.Summary statistics (1992-2016).

	CO_2				GDPpc			
	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.
Albania	3.6566	1.2358	1.5425	6.0187	2584.5	990.42	1086.9	4075.3
B&H	15.461	6.1799	3.2280	23.867	2535.9	1031.4	565.91	3697.7
Bulgaria	50.533	4.7487	42.480	58.135	3797.9	998.16	2653.0	5425.6
Croatia	20.105	2.5963	16.342	24.956	9244.1	1851.7	5803.3	11756
Greece	95.963	12.436	71.077	114.13	19394	2730.3	15757	24288
Romania	99.820	18.363	73.365	131.23	4614.5	1336.1	2888.8	7013.0
Serbia	45.548	5.8128	35.449	57.581	3046.2	854.44	1725.0	4201.1
Slovenia	15.756	1.1994	13.490	18.220	16640	3138.0	10930	20891
Macedonia	10.225	1.4219	7.9165	12.615	3157.1	578.70	2510.6	4221.2

To further illuminate the data, Figures 1 and 2 show the changing trends for SEE countries. It is evident that CO_2 emissions of the two largest polluters from all SEE countries - Romania and Greece - decreased in the previous decade. Bulgaria and Serbia are among the medium polluters in the SEE countries, and do not record drastic changes in the level of CO_2 emissions. The same situation occurs in the countries that record low levels of pollution.

Looking at GDP per capita, there was a clear decline in all SEE countries in 2008, which was a direct consequence of the global economic crisis. Most countries recovered from the crisis and recorded GDP per capita growth, but the situation in Greece was particularly interesting. The most significant decline after the crisis was recorded in Greece, and the stagnation is still apparent. This was caused by the extremely sharp crisis of public debt, which was later deepened by the systemic and political crisis.

Figure 1. CO_2 emissions (territorial emissions in $MtCO_2$)

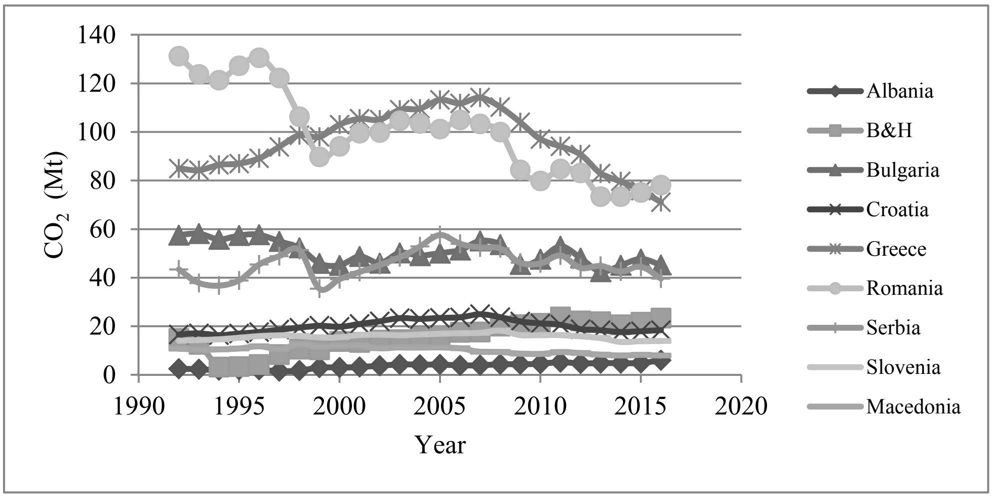
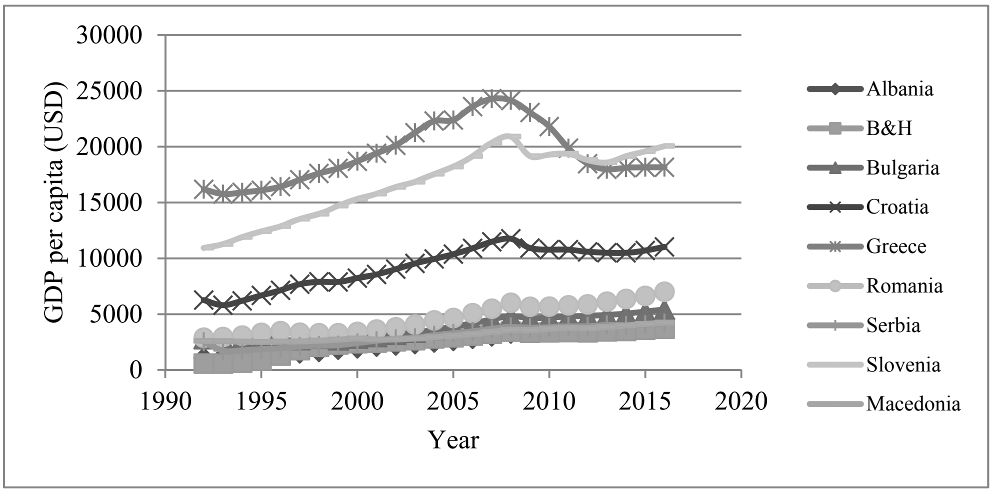


Figure 2. GDP per capita (constant USD, 2005)



3. Methodology

The research uses vector error correction model (VECM) and Granger's causality analysis. In order to approach this analysis of the long-term and short-term interactions of variables, it is necessary first to test the existence of unit roots in the panel data. After obtaining the evidence that the data in the panel are stationary at level, and after the conversion to the first difference the data are non-stationary, the cointegration testing is initiated. If the results obtained show that the variables are cointegrated, a causality analysis based on the vector error correction model, Granger's causality analysis and Wald test are examined, where the interplay of the variables in the long and short term is examined.

3.1. Panel unit root testing

The empirical literature offers a wide variety of panel unit root tests. These are primarily extensions of univariate cases which include cross-section dimension. In this paper authors consider 4 tests which are customarily used in panel cointegration analysis: the Levin, Lin & Chu (LLC) test (Levin, Lin, & Chu, 2002), theIm, Pesaran and Shin W-stat (IPS) test (Im, Pesaran,& Shin, 2003), the ADF - Fisher Chi-square (Fisher-ADF) test (Maddala &Wu, 1999) and thePP - Fisher Chi-square (Fisher-PP) test (Choi, 2001). These tests use the panel specification of the AR(1) data generating process, which was given by Augmented Dickey-Fuller (ADF) regression (deterministic terms are excluded for simplicity reasons):

$$\Delta y_{i,t} = \rho_i y_{i,t-1} + \sum_{p=1}^{P_i} \phi_{ip} \Delta y_{i,t-p} + \varepsilon_{it} \quad (1)$$

All these test the $H_0: \rho_i = 0 \; \forall i$ (every individual process has a unit root) against the $H_1: \exists i \in \{1, \dots, N\}, \rho_i < 0$ (at least one individual process does not have a unit root). However, they diverge in initial assumptions and statistical inference.

3.2. Panel cointegration testing

When panel cointergation testing is considered, two tests which are commonly used are Johansen-Fisher test (Maddala & Wu, 1999) and Pedroni test (Pedroni, 2004). Johansen-Fisher test indicates not only the presence of cointegration, but also the number of cointegrating vectors, which is an obvious advantage. Be that as it may, Pedroni test offers more variety of test statistics.

Johansen-Fisher approach is based on the Vector-Error Correction representation of VAR process (Johansen, 1988):

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{p=1}^{P-1} \Gamma_p \Delta Y_{t-p} + u_{i,t} \quad (2)$$

where Y_t is a k-dimensional vector of possible cointegration variables. It proposes two tests to investigate the presence of cointegration between non-stationary time series: the likelihood ratio trace statistics and the maximum eigenvalue statistics:

$$LR_{trace}(r_0, k) = -T \sum_{j=r_0}^{k} ln(1 - \lambda_j) \quad (3)$$

$$LR_{max}(r_0, r_0 + 1) = -T \sum_{j=r_0}^{k} ln(1 - \lambda_{r_0}) \quad (4)$$

where r_0, $r_0 = rank(\Pi)$, is a number of assumed cointegrating relations and λ_j is the j-th largest eigenvalue of the matrix Π. The same $H_0{:}\, rank(\Pi)) = r_0$ is tested by both tests, against the $H_1{:}\, rank(\Pi) = k$ in case of LR_{trace}, or $H_1{:}\, rank(\Pi) = r_0 + 1$, in case of LR_{max}. Based on Fisher's method, Maddala and Wu (1999) propose panel alternative of Johansen (1988) univariate case.

The idea behind Pedroni's approach states that there is cointegration between two or more non-stationary time series if any stationary linear combination of them exists (Pedroni, 2004). Hence, residuals from their stationary linear combination are also stationary. Based on auxiliary regressions (5) and (6) of the OLS-estimated residuals:

$$\hat{\varepsilon}_{i,t} = \rho\hat{\varepsilon}_{i,t-1} + \mu_{i,t} \tag{5}$$

$$\hat{\varepsilon}_{i,t} = \rho\hat{\varepsilon}_{i,t-1} + \sum_{p=1}^{P_i} \phi_{ip}\Delta\hat{\varepsilon}_{i,t-p} + \mu^{*}_{i,t} \tag{6}$$

There are two groups of panel cointegration test statistics. The first group comprises four statistics that has been derived assuming common AR process: semi-parametric ν-, ρ- and t- statistics, and parametric panel ADF t-statistics. The second group comprises three statistics that has been derived assuming varying individual processes: Phillip-Peron ρ- and t-statistics and ADF t-statistics computed on group-mean principle.

3.3. Panel Causality

The presence of cointegration does not give information about the direction of the causality between variables. For this reason, authors like Al-mulali (2011), Hwang & Yoo (2014), Shahbaz et al. (2013) and Lean & Smyth, 2010), among others, propose causality testing based on the panel analogue of VECM equation given in (2). The rudimentary idea is to decompose matrix Π to the vector of cointegrating coefficients β, and the vector of adjustment coefficients α. The latter tells a speed of ΔY_tadjustment to the lagged "error", i.e. deviation from the long run cointegrating relation given by equation $\beta' Y_{t-1} = u_{t-1}$. Therefore, the panel version of the equation (2) can be rewritten as a system of k VECM equations:

$$\Delta Y_{j;i,t} = \alpha_j \beta' Y_{i,t-1} + \sum_{l=1}^{k}\sum_{p=1}^{P-1} \Gamma_{j,l;p}\Delta Y_{j,l;i,t-p} + u_{j;i,t}, \quad j = 1, \dots, k \tag{7}$$

where α_j is the j-th row of the vector α and $\Gamma_{j,l;p}$ is a *(j,l)* element of matrix Γ_p. The statistical significance of parameter α_j indicates whether variable $Y_{j;i,t}$ makes an adjustment to restore long run relation once a deviation u_{t-1} occurs. On the other hand, significance of $\Gamma_{j,l;p}$ indicates short run Granger causality from variable l to variable j. The H_0: $\Gamma_{j,l;p} = 0\ \forall i, p$ is formally tested using standard Wald F-test.

4. Results

The results, naturally, follow the same steps as the methodology part of the paper. First panel unit root test results are presented, followed by cointegration tests results, and finally causality results.

4.1. Panel unit root results

The results of panel unit root tests are presented in Table 2. All results undoubtedly display that both variables – CO_2andGDPpcare not stationary at level, but when converted to first difference they become stationary. In other words, the results indicate that variables contain a panel unit root, i.e. all variables are integrated of the same order. This allows us to proceed to the cointegration testing.

Table 2. Panel unit root test results

Variable	**Levin, Lin & Chu t***			
	Level		First Difference	
	Intercept	Intercept & Trend	Intercept	Intercept & Trend
CO_2	-1.19811	0.64392	-8.95315***	-9.59684***
GDPpc	-0.57808	-1.53996	-8.96805***	-8.05978***
	Im, Pesaran and Shin W-stat			
	Level		First Difference	
	Intercept	Intercept & Trend	Intercept	Intercept & Trend
CO_2	-0.16124	1.04184	-8.72419***	-8.80017***
GDPpc	1.94589	-0.82854	-7.71065***	-6.76066***
	ADF - Fisher Chi-square			
	Level		First Difference	
	Intercept	Intercept & Trend	Intercept	Intercept & Trend
CO_2	17.6906	19.2473	103.926***	93.6859***
GDPpc	20.1263	27.9931	88.9270***	79.9458***
	PP - Fisher Chi-square			
	Level		First Difference	
	Intercept	Intercept & Trend	Intercept	Intercept & Trend
CO_2	10.4310	15.2772	108.441***	102.873***
GDPpc	7.83000	14.2551	86.9452***	79.1320***

Note: *** denotes statistical significance at 1% level; Schwarz automatics election of the lag length has been used for the unit root tests; Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

4.2. Cointegration tests results

Table 3 provides results from the Johansen Fisher Panel Cointegration test. It shows that there is at most one cointegrated equation, meaning that there is cointegration among the two variables. This test is sufficient to carry on to causality testing.

Table 3. Johansen Fisher Panel Cointegration Test

	Linear deterministic trend			
	Null hypothesis:Variables are not cointegrated			
Hypothesized No. of CE(s)	Fisher Stat. (from trace test)	Probability	Fisher Stat. (from Max-Eigen test)	Probability
None	53.53***	0.0000	51.15***	0.0001
At most 1	21.24	0.2675	21.24	0.2675

Note: *** denotes statistical significance at 1% level; Intercept (no trend) in CE and VAR has been used; Lags interval (in first differences): 1 1; Probabilities for Fisher Stat. are computed using asymptotic Chi-square distribution.

For the purposes of obtaining an additional proof of cointegration, aPedroni Residual Cointegration test with deterministic intercept and trend was done. Results of the Pedroni Residual Cointegration test are shown in Table 4.

Table 4. Pedroni Residual Cointegration Test

Null hypothesis: No cointegration				
Test	**Deterministic intercept and deterministic trend**			
	Alternative hypothesis: common AR coefs. (within-dimension)			
	Statistics	Probability	Weighted Statistics	Probability
Panel v-Statistic	4.505027***	0.0000	1.781807**	0.0374
Panel rho-Statistic	-0.409662	0.3410	-1.144086	0.1263
Panel PP-Statistic	-1.976377**	0.0241	-3.263304***	0.0006
Panel ADF-Statistic	-4.688921***	0.0000	-3.945528***	0.0000
	Alternative hypothesis: individual AR coefs. (between-dimension)			
	Statistics	Probability	Weighted Statistics	Probability
Panel v-Statistic	0.240878	0.5952	-	-
Panel rho-Statistic	-3.511160***	0.0002	-	-
Panel PP-Statistic	-4.723986***	0.0000	-	-

Note: *** denotes statistical significance at <1% level; ** denotes statistical significance at 5% level; Automatic lag length selection based on SIC with a max lag of 4 has been used; Newey-West Automatic settings for automatic optimal bandwidth selection and Bartlett kernel have been used.

Eight statistics out of eleven reject the null hypothesis of no-cointegration. As the majority of statistics prove cointegration, the Pedronicointegration test results also indicate that two variables (CO_2 andGDPpc) are cointegreted in the SEE countries. This indicates that GDPpchas a long run relationship with the CO_2 emissions. As variables are cointegrated, the causality analysis based on the vector error correction model - VECM can be performed.

4.3. Causality results

The error correction part of Table 5 displays the estimated coefficients of the variables CO_2 and GDPpc speed adjustments to the lagged deviations from long run cointegrating relation. The test results show that CO_2 coefficient is negative and statistically significant. This means that there is a long run causality running from GDPpc to CO_2, i.e. there is speed of adjustment towards long run equilibrium. The speed of adjustment is 2.0279%, meaning that the whole system is going back to long run equilibrium by the speed of 2.0279% annually. On the other hand, GDPpc coefficient is negative but not statistically significant, meaning that there is no long run causality running from CO_2 to GDPpc.

The Short run Granger causality in the Table 5 shows the results of the short run causality testing based on Wald tests with a χ^2 distribution. There is a positive bidirectional short run causal relationship between CO_2 and GDPpc.

Table 5. Causality analysis results

	Short run Granger causality		**Error correction**	
	ΔCO2	ΔGDPpc	ECT(-1)	Coeff.
ΔCO2	-	7.842548**	-3.018910***	-0.020279
ΔGDP	96.10152***	-	-0.531397	-0.327485

Note: values of the t-statistic are reported, with the accompanying p-values where *** denotes statistical significance at 1% level; ** denotes statistical significance at 5% level;Δ is the first difference operator; ECT(-1) represents the error correction term lagged one year.

In summation, the results of causality testing indicate that in the short run there is a positive bidirectional causal relationship between CO_2 and GDPpc, but in the long run, there is causality running just from GDPpc to CO_2, with the speed of adjustment 2.0279%.

5. Discussion and Policy Implications

Research on the interdependence between environmental degradation and economic growth for SEE countries is important because it raises awareness about environmental problems. Nowadays, people are aware of the fact that environmental degradation is a global problem and that it can endanger well-being in general (Stanojević & Đorđević, 2016). Well-being as a broad term has to include various economic, environmental and social aspects (Munitlak Ivanović et al., 2016). The work on environmental protection represents a continuous and long-term effort of the state, as well as of all other stakeholders (Mitić & Cvetanović, 2017).This research is also significant for providing context and information to policy makers in order to help them select and adopt appropriate policies.

The efforts to reduce CO_2 emissions and provide a satisfactory rate of economic growth in SEE countries can be partially achieved through cap and trade system. Transferable permits limit the maximum amount of pollution that an entity can emit into the environment. Application of transferable licenses is rooted in the idea that an increase in pollution from one source must be followed by aparallel reduction of pollution from other sources (Munitlak Ivanović, Raspopović & Mitić, 2014a). In January 2005, the EU started to develop the European Union's Emissions Trading Scheme (EU ETS), the world's first large store of CO_2 emissions (Ellerman & Buchner, 2007), which is one of the cornerstones of EU policy to combat climate change and represents a key instrument for the economical reduction of GHG emissions (Munitlak Ivanović, Raspopović & Mitić, 2014a). It operates in all 28 EU Member States, Iceland, Liechtenstein and Norway. The five SEE countries observed in this survey are already members of the EU ETS. Other four non-EU countries develop and implement various projects that serve as preparation for entry into the scheme of trading.

Ecological taxes, as a significant policy instrument for tackling negative externalities, can be characterized as taxes whose basis is in a physical unit or a process that has a negative impact on the environment. The important characteristic of these taxes is that the revenues that the state collects in this way are directed to the protection of the environment (Munitlak Ivanović, Mitić & Raspopović, 2014b). As increased concentrations of CO_2 emissions affect environmental degradation and climate change, and carbon tax is often proposed by economists as an adequate policy instrument for reducing these emissions. "The carbon tax to be imposed is based on the amount of CO2 emissions generated during the combustion; this policy would encourage firms and households to reduce fossil fuel usage and shift the fuel mix towards less-carbon-intensive fuel such as natural gas." (Jorgenson et al., 1992).

Also, renewable energy sources compared to fossil fuels are an alternative with the potential to reduce GHG emissions, i.e. they have a positive effect on the environment and health. Increasing the use of renewable sources in the coming years can bring significant benefits in terms of green jobs and green growth. This could be a decisive factor in the SEE countries' aspirations towards sustainable economic growth.

6. Concluding Remarks

With frequent non-characteristic weather and extreme climatic changes in the world, the international community has shown significant concern about environmental degradation. To solve this problem, many countries have adopted different CO_2 emission measures. Be that as it may, it is necessary to investigate the impact of environmental degradation on economic growth from the point of view of environmental economics. This research is motivated by the need to investigate the interdependence of environmental degradation and economic growth for 9 SEE countries over the period 1992–2016. The empirical results of causality testing reveal that in the short run there is a positive bidirectional causal relationship between CO_2 and GDPpc, but in the long run, there is causality running just from GDPpc to CO_2, with the2.0279% speed of adjustment. The result confirms the finding of the previous similar research that there is a significant connection between environmental degradation and economic growth in general. This is consistent with theoretical outlooks as well.

In pursuit of adequate policy measures, SEE countries need to work on developing and improving all aspects of mitigating environmental degradation using various economic measures and instruments. Some of them, proposed in this paper are participating in European Union's Emissions Trading Scheme for non-EU members, further developing environmental taxes, or even more precise, carbon taxes in all SEE countries, and the use of renewable energy sources on a larger scale.

References

Abdullah, L. (2015). Linear Relationship between CO2 Emissions and Economic Variables: Evidence from a Developed Country and a Developing Country. *Journal of Sustainable Development*, *8*(2), 66. doi: 10.5539/jsd.v8n2p66

Al-Mulali, U. (2011). Oil consumption, CO2 emission and economic growth in MENA countries.*Energy*, *36*(10), 6165-6171. doi: 10.1016/j.energy.2011.07.048

Al-Mulali, U., & Sab, C. N. B. C. (2012). The impact of energy consumption and CO2 emission on the economic growth and financial development in the Sub Saharan African countries.*Energy*, *39*(1), 180-186. doi: 10.1016/j.energy.2012.01.032

Arouri, M. E. H., Youssef, A. B., M'henni, H., &Rault, C. (2012). Energy consumption, economic growth and CO2 emissions in Middle East and North African countries. *Energy policy*, *45*, 342-349. doi: 10.1016/j.enpol.2012.02.042

Azam, M. (2016). Does environmental degradation shackle economic growth? A panel data investigation on 11 Asian countries. *Renewable and Sustainable Energy Reviews*, *65*, 175-182. doi: 10.1016/j.rser.2016.06.087

Boden, T., Andres R., & Marland, G. (2017). Global, Regional, and National Fossil-Fuel CO2 Emissions. Carbon Dioxide Information Analysis Center (CDIAC), Oak Ridge National Laboratory, US Department of Energy, Oak Ridge, Tenn., USA doi:10.3334/CDIAC/00001_V2017

Borhan, H., Ahmed, E. M., &Hitam, M. (2012). The impact of CO2 on economic growth in ASEAN 8. *Procedia-Social and Behavioral Sciences*, *35*, 389-397. doi: 10.1016/j.sbspro.2012.02.103

Choi, I. (2001). Unit root tests for panel data. *Journal of international money and Finance*, *20*(2), 249-272. doi: 10.1016/S0261-5606(00)00048-6

Domazet, I., & Jovanović, O. (2016). Očuvanje životne sredine i tehnogeni izvori zagađenja. *Ecologica*, *23*(83), 529-533.

Ellerman, A. D., & Buchner, B. K. (2007). The European Union emissions trading scheme: origins, allocation, and early results. *Review of environmental economics and policy*, *1*(1), 66-87. doi: 10.1093/reep/rem003

Falkner, R. (2016). The Paris Agreement and the new logic of international climate politics. *International Affairs*, *92*(5), 1107-1125. doi: 10.1111/1468-2346.12708

Friedl, B., &Getzner, M. (2003). Determinants of CO2 emissions in a small open economy. *Ecological economics*, *45*(1), 133-148. doi: 10.1016/S0921-8009(03)00008-9

Hwang, J. H., &Yoo, S. H. (2014). Energy consumption, CO 2 emissions, and economic growth: evidence from Indonesia. *Quality & Quantity*, *48*(1), 63-73. doi: 10.1007/s11135-012-9749-5

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of econometrics*, *115*(1), 53-74.doi: 10.1016/S0304-4076(03)00092-7

Jeločnik, M., Subić, J., Zubović J., & Zdravković, A. (2016). Ekonomski aspekti primene obnovljivih izvora energije u procesu navodnjavanja u povrtarstvu. *Ecologica*, 23(83), 473-479.

Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of economic dynamics and control*, *12*(2-3), 231-254.doi: 10.1016/0165-1889(88)90041-3

Jorgenson, D. W., Slesnick, D. T., Wilcoxen, P. J., Joskow, P. L., & Kopp, R. (1992). Carbon taxes and economic welfare. *Brookings Papers on Economic Activity. Microeconomics*, *1992*, 393-454. doi: 10.2307/2534767

Kalaš, B., Mirović, V., & Pjanić, M. (2017). Economic and Tax Competitiveness in Selected South East European Countries. *Economic Analysis*, *50*(3-4), 55-65.

Kasman, A., & Duman, Y. S. (2015). CO2 emissions, economic growth, energy consumption, trade and urbanization in new EU member and candidate countries: a panel data analysis. *Economic Modelling*, *44*, 97-103. doi: 10.1016/j.econmod.2014.10.022

Lean, H. H., & Smyth, R. (2010). CO2 emissions, electricity consumption and output in ASEAN. *Applied Energy*, *87*(6), 1858-1864. doi: 10.1016/ j.apenergy.2010.02.003

Levin, A., Lin, C. F., & Chu, C. S. J. (2002). Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of econometrics*, *108*(1), 1-24.doi: 10.1016/S0304-4076(01)00098-7

Maddala, G. S., & Wu, S. (1999). A comparative study of unit root tests with panel data and a new simple test.*Oxford Bulletin of Economics and statistics*, *61*(S1), 631-652. doi: 10.1111/1468-0084.0610s1631

Manne, A. S., & Richels, R. G. (1990). CO2 emission limits: an economic cost analysis for the USA. *The Energy Journal*, 51-74.

Martínez-Zarzoso, I., & Bengochea-Morancho, A. (2004). Pooled mean group estimation of an environmental Kuznets curve for CO2. *Economics Letters*, *82*(1), 121-126. doi: 10.1016/j.econlet.2003.07.008

Mitić, P., & Cvetanović, S. (2017). Međuzavisnost privredne razvijenosti i emisije CO2 – studija slučaja Republike Srbije i Republike Hrvatske. *Ecologica*, *24*(88), 809-814.

Mitić, P., Munitlak Ivanović, O., & Zdravković, A. (2017). A cointegration analysis of real GDP and CO2 emissions in transitional countries. *Sustainability*, *9*(4), 568. doi: 10.3390/su9040568

Munitlak Ivanović, O., Mitić, P., & Raspopović, N. (2014b). Fiskalni prihodi i ekonomska uloga ekoloških poreza u održivoj ekonomiji. *Ecologica*, *21*(75), 375-378.

MunitlakIvanović, O., Mitić, P., Raspopović, N., & Jovanović, L. (2016). Značaj GDPPC kao determinante indeksa blagostanja. *Ecologica*, *23*(83), 449-453.

Munitlak Ivanović, O., Raspopović, N., & Mitić, P. (2014a). Specifični oblici međunarodne trgovine – "cap and trade" sistem. *Poslovna ekonomija*, 8(2), 115-126.

Narayan, P. K., & Narayan, S. (2010). Carbon dioxide emissions and economic growth: panel data evidence from developing countries. *Energy Policy*, *38*(1), 661-666. doi: 10.1016/j.enpol.2009.09.005

Ogawa, Y. (1991). Economic activity and the greenhouse effect. *The Energy Journal*, 23-35.

Pedroni, P. (2004). Panel cointegration: asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. *Econometric theory*, *20*(3), 597-625. doi: 10.1017/S0266466604203073

Salahuddin, M., & Gow, J. (2014). Economic growth, energy consumption and CO2 emissions in Gulf Cooperation Council countries. *Energy*, *73*, 44-58. doi: 10.1016/j.energy.2014.05.054

Sebri, M., & Ben-Salha, O. (2014). On the causal dynamics between economic growth, renewable energy consumption, CO2 emissions and trade openness: Fresh evidence from BRICS countries. *Renewable and Sustainable Energy Reviews*, *39*, 14-23. doi: 10.1016/j.rser.2014.07.033

Shafik, N., & Bandyopadhyay, S. (1992). *Economic growth and environmental quality: time-series and cross-country evidence* (Vol. 904). World Bank Publications.

Shahbaz, M., Hye, Q. M. A., Tiwari, A. K., & Leitão, N. C. (2013). Economic growth, energy consumption, financial development, international trade and CO2 emissions in Indonesia. *Renewable and Sustainable Energy Reviews*, *25*, 109-121. doi: 10.1016/j.rser.2013.04.009

Shahbaz, M., Solarin, S. A., Sbia, R., & Bibi, S. (2015). Does energy intensity contribute to CO2 emissions? A trivariate analysis in selected African countries. *Ecological indicators*, *50*, 215-224. doi: 10.1016/j.ecolind.2014.11.007

Stanojević, D., Mitić, P., & Rakić, S. (2013, April). Strategija bankarskog sektora u kontekstu održivog razvoja – perspective Srbije. *18th International Scientific Conference SM 2013: Strategic Management and Decision Support Systems in Strategic Management, Topic: The Role of Corporate Management in Sustainable Development*, (pp. 437-446). Palić – Subotica, Serbia: Faculty of Economics Subotica.

Stojanović, D., & Đorđević, B. (2016). Sistem trgovanja emisijama CO_2 – potencijali razvoja u Republici Srbiji. *Ecologica*, 23(81), 89-94.

Tamazian, A., Chousa, J. P., & Vadlamannati, K. C. (2009). Does higher economic and financial development lead to environmental degradation: evidence from BRIC countries. *Energy policy*, *37*(1), 246-253. doi: 10.1016/j.enpol.2008.08.025

unctadstat.unctad.org. (2017). *US Dollars at constant prices (2005) per capita*. [online] Available at: http://unctadstat.unctad.org/ [Accessed 6 Sep. 2017].

unfccc.int. (2018). *The Paris Agreement - main page*. [online] Available at: http://unfccc.int/paris_agreement/items/9485.php [Accessed 8 June 2018].

ISTRAŽIVANJE ODNOSA EKONOMSKOG RASTA I ŽIVOTNE SREDINE U DEVET ZEMALJA JUGOISTOČNE EVROPE

Apstrakt: Rad istražuje međuzavisnost degradacije životne sredine (CO_2 emisije) i ekonomskog rasta (BDP po glavi stanovnika) u devet zemalja Jugoistočne Evrope u periodu od 1992. do 2016. godine. Rezultati istraživanja Granger-ove analize uzročnosti pokazuju da u kratkom roku postoji pozitivna dvosmerna veza između CO_2 emisija i BDP po glavi stanovnika, dok u dugom roku postoji uzročnost koja se kreće samo od BDP-a po glavi stanovnika ka CO_2 emisijama, sa brzinom prilagođavanja od 2,0279%. U potrazi za adekvatnim merama politike, donosioci odluka zemlja Jugoistočne Evrope treba da rade na uključivanju zemalja koje nisu članice EU u Šeme trgovanja emisijama Evropske unije ili slične sisteme, kao i na daljem razvijanju oporezivanja štetnih emisija i korišćenju obnovljivih izvora energije u većoj meri.

Ključne reči: CO_2 emisije, BDP po glavi stanovnika, degradacija životne sredine, ekonomski rast, Granger-ova analiza uzročnosti, panel podaci

Authors' biographies

Petar Mitić is a Research Assistant at the Institute of Economic Sciences in Belgrade, Republic of Serbia, where he is developing and working on both domestic and international projects, writing scientific papers, and organising conferences, round tables and other events for both project and scientific purposes. He is writing a PhD thesis entitled "Interdependence between Economic Growth and Environmental Pollution in Southeastern European Countries". He is also enrolled in a master course in Applied Statistics at the Centre for Applied Statistics, University of Novi Sad. The main areas of interest are: Environmental Economics, Sustainable Development, Macroeconomics, Ecological Economics, and Econometrics.

Slobodan Cvetanović is a Full Professor at the Faculty of Economics, University of Niš. He teaches Macroeconomics and Financing the Capital Development of the Economy (undergraduate studies), Open Economy Macroeconomics (postgraduate studies), and Macroeconomics and Macroeconomic Management (doctoral studies). Professor Cvetanović has authored over 400 scientific articles and about 40 books. As author and co-author, he has published articles in world's relevant magazines. His narrow fields of interest include macroeconomics, economic development; innovation, sustainable development.