ECONOMIC GROWTH AND ENVIRONMENTAL PROTECTION

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Abstract
In this research, we analyzed the link between economic growth and environmental protection for countries like: Austria, Czech Republic and Hungary. For the economic growth we used gross domestic products (GDP) as a proxy and for the environmental protection we decided to use general government expenditure by function such as: environmental protection, waste management, pollution abatement, protection of biodiversity and landscape and R&D environmental protection. Due to the restrictions in finding the data, we decided that the period under investigation would be 1995-2017. The empirical results confirmed the presence of a positive link between GDP and expenditures for all the countries analyzed, a fact confirmed by the other existing studies. After applying the Granger causality test, only in the case of Hungary was identified a unidirectional causality from GDP to R&D environmental protection.

Key words: *GDP, expenditure, sustainable development, multiple linear regression, Granger causality.*

JEL Classification: *H50, O44.*

I. INTRODUCTION

The purpose of this paper consists in an analysis of the relationship between economic growth and environmental protection. The present article is addressed to both theorists and practitioners in this field, as well as to all persons who are concerned about this phenomenon. First of all, we will debate what the protection of the environment entails. Kaye and Worrel (2012) discuss sustainable development by adopting green procurement programs. In our analysis, we will discuss, in the theoretical part, the importance of green public procurement. Green purchases make a significant contribution to the sustainable development of the economy and to the promotion of innovation. Suhonen et al. (2019) considers innovation as a necessity, in the context of green public procurement and, implicitly, for the growth and stimulation of the economy. Secondly, in the practical part we will stop to deepen the relationship between economic growth and environmental protection, this example being applied for three states of the European Union, namely: Austria, the Czech Republic and Hungary. Previous studies have shown the direct link between green public procurement and their impact on the sustainable growth of the economy. Aligning the European states with the requirements imposed by the European Commission, regarding green public procurement should be one of the main objectives set in their development strategy. Raymond (2008) has brought to the forefront the importance of transparency in public procurement. In 2008, the European Commission, following its annual analyzes, concluded that each nation, for a sustainable growth of their economy and for a development of the standard of living of citizens, should have as main objective, in the field of public procurement, green public procurement in a total amount of 50%. Kattel and Lember (2010) recommend to developing states to take the necessary actions to introduce green public procurement. Developed states have understood the importance of these green acquisitions, and have adopted, in their country strategy, this goal quite quickly, to increase the standard of living among citizens. Romania has very late aligned with these directions imposed by the European Commission, and in 2019 we are still in a period when we have not reached the target of the main objective, namely the 50% of public procurement contracts to be green public procurement. In this case, the competent authorities must understand and implement the change of the strategy, in the matter of new acquisitions, for the growth of the Romanian economy and the quality of life, in the long term.

Most of the time the price is the defining element in awarding a contract, or the green public procurements initially have a higher price, compared to the prices practiced in the market, for similar products, but the quality of the product and the life cycle of the product definitely exceed a product at a significantly lower price. Cader et al. (2018) discuss in their work the significance attributed to green procurement. They analyze the paradigm that the sustainable product is more expensive, but optimizes the budgetary, logistical, human and technological resources, focusing on sustainability and quality. Another important aspect of public procurement is represented by their quality and the elimination of corruption. Campbell (2017) gives the example of North Korea, regarding public procurement policy, considering that these contracts are vulnerable to corruption. The

solution found in their study is transparency. Next, we refer to the protection of the environment by researching the issue of green public procurement. We will analyze the most eloquent studies on this topic, namely green (ecological) public procurement and their need for sustainable growth of a state's economy. The issue of green public procurement must concern the whole society due to the significant impact it has on the environment, as well as on all the inhabitants of a country. Therefore, the central public administration of any state, through its public policies, must have the necessary legislative levers to include ecological criteria in the process of awarding the procurement of public goods and services. A first observation, noted by the authors, is that green public procurement would increase the confidence of the population in the state institutions, among the citizens, as it would significantly change the life of the inhabitants of a state, by decreasing the degree of pollution, for example. In the specialized literature, we will address Romania's issues regarding green public procurement, as well as other states that are or are not members of the European Union. In the practical part, we will analyze the situation of three EU states, respectively: Austria, the Czech Republic and Hungary, due to the data we have available in this regard. Due to the restrictions on finding data, we cannot deal with the case of Romania, as part of the Granger causality test.

The paper is organized as follows. Review of the scientific literature a brief research of the literature that tackled the study of the relationship between economic growth and environmental protection. Research methodology describes the data source and methodology. Results and discussion presents the results of the empirical study on the relationship between GDP and general government expenditure by function. The last part contains conclusions.

II. REVIEW OF THE SCIENTIFIC LITERATURE

The protection of the environment is an extremely important issue within the states of the European Union. One way to support the environment is represented by green public procurement. This concept expresses, by its nature, sustainability, innovation, as well as the viable growth of the economy of developing countries. Kaye and Worrel (2012) advocate for the importance attributed to the environment through programs to stimulate green public procurement. Sergi et al.(2019) converge on the idea that smart cities stimulate global economic growth. The change must be characterized by a smart environment, smart technologies, smart human capital, smart infrastructure. Simachey and Kuzyk (2019) support the idea of sustainable development through innovation, referring to the situation of Russia. The article analyzes the state policies that led to innovation and sets out the achievements and issues for each stage of these government policies.Defending the environment is, basically, interpreted by improving the use of resources. Zavyalova and Studenikin (2019) discuss Russia's expanded economic growth model and point out that as a country with rich natural resources the inhabitants of this country are investing in green procurement. In order to optimize the resources available to the states, it is imperative to analyze, strictly, all contracts regarding public procurement. Efficiency in the use of public money must be one of the objectives for the economic development of the states.

According to Aldenius and Khan (2017) green public procurement has the potential to contribute to the improvement of the environment. Green public procurement (GPP) is defined by the European Commission as the process by which “public authorities try to procure goods, services and works with a reduced impact on the environment throughout their life cycle compared to goods, services and works with the same primary function, which would otherwise have been purchased.". Grandia (2016) develops the idea about the impact of green public procurement on the environment, saying: "the more durable goods and services the government buys, the greater the impact on the market and the environment will be”. However, it is found that only 20% of the GDP of European countries represents green public procurement, given that most purchases, regardless of the country of origin, are made by the state, and the state is the largest buyer on the market. In the opinion of Onicioiu and Chiriță (2009) green public procurement is based on a series of principles, as follows: "non-discrimination, equal treatment, mutual recognition, transparency, proportionality, efficiency of the use of public funds". It is important to underline the importance of economic public procurement in sustainable growth for poorly developed countries, as is the case of Romania. At the same time, about the strategic sustainable development and about the sustainability of green public procurement, as well as about the product life cycle, it refers also (Bratt et al., 2013) in his work. The European Commission defines the life cycle cost of a product (LLC) as the sum of all the costs of the respective good, over the entire lifetime. Within these costs are the purchase price (delivery, installation, insurance, etc.), operating costs (water, energy, fuel, maintenance), as well as end-of-life costs (disposing of the product or selling it). All these maintenance costs have a significantly lower value than the maintenance costs of a product without ecological characteristics, and the sustainability of the green product and its benefits lie above the life cycle of a product with normal life characteristics. The benefits of green public procurement lead to substantial savings in water, energy, fuel, maintenance. The purchase price of a product that has ecological characteristics is, however, higher than that of a product with normal characteristics. Although the price of ecological public procurement is higher at the beginning, the product maintenance is much lower compared to a similar non-ecological product.

Therefore, it is necessary to align Romania with the developed states, in terms of green procurement, by adopting minimum criteria, specification and compliance with a multiannual action plan (European Commission, 2019). All these three criteria are particularly important for Romania, and ecological public procurement must be based on the life cycle of the purchased products and the demonstration of their long-term utility, with the help of scientific evidence. The main advantages of purchasing organic products include: reducing pollution, protecting the environment, as well as easily recyclable packaging.

According to a report by European Commission (2016), in 2012, the Local Council of Baia Mare Municipality made an ecological public procurement consisting of means of public transport, which had ecological characteristics, namely renewable fuels. It was the first purchase of this type in Romania and the purchase price, consumption, maintenance, as well as operational costs were taken into account. The sum of all four elements is greater than a public procurement without ecological characteristics, but the product life cycle and the protection of the environment are only two of the main advantages of purchasing such car models. Regarding public transport (Hickman and Banister, 2014) state that environmentally friendly public transport helps to combat pollution and noise. One of the characteristics of these green products is that their packaging has a significant impact on the environment, reducing the large number of waste and garbage, so present in Romania. If we analyze carefully how to spend public money, the large amount of waste existing in Romania and the pollution will be reduced and these examples of green consumer behavior will be encouraged. These green products must be purchased in a manner in which the environmental impact is significant. Therefore, Romania has made considerable progress since 2012, even though such purchases are significantly lower than the European Union average. The level of green public procurement (Renda et al., 2012) is below the objective set by the European Commission, which provided that 50% of public procurement to be green public procurement. At the same time, Romania, along with 12 other countries such as: Portugal, Ireland, Poland, Czech Republic, Finland, Slovenia, Hungary, Bulgaria, Greece, Latvia and Estonia - has an absorption level of less than 20%.

Another important aspect to be added, which is in the field of organic products, is supporting a market for organic products. In Romania, there are a number of producers that could produce products with ecological characteristics, but they do not benefit from state support and legislative support. At the same time, the price charged may be higher than the price of a product of the same range, and this has a significant impact on the consumer, discouraging him from buying the respective good or service on the market. Therefore, in this segment of the market, it is imperative to adopt specific strategies to encourage the producers of products with ecological characteristics. The following categories are included in the green procurement category, as follows: IT products (energy efficient computers), furniture products (solid wood products that come from forests and have a high and durable quality), office supplies, recyclable paper, lights, lighting, construction products and materials, catering services, ecological public transport. Certainly, green public procurement, as the specialized literature shows, plays an essential role in supporting and developing the economy of a state. The main components of this concept are product innovation and sustainability. It is essential to make a change and to have as many ecological contracts worldwide. States around the world are discussing these issues and are trying, through a series of concrete measures, to increase their number. We will look at how this will be made possible, as well as the concrete measures to be taken by EU Member States on this topic. We conclude by asserting that a growth of the world economy today translates, first and foremost, into the latest technologies. Green purchases could be considered as the engine of growth of a viable economy and of diminishing technological gaps.

Table no 1. Previous related studies on green public procurement

Author(s)	Period	Sample	Methodology	Findings
Bai, C., Shah, P., Zhu, Q. and Sarkis, J. (2018)	1997-2015	40 potential green products for removal	CPT, NRST, FCM method	The results of this technique show that the green products targeted for removal can be effectively deleted
Cader Da Silva, R., Betiol, L., Villac, T. and Nonato, R. (2018)	June 2014 and September 2015	Official documents related to the Ministry of Planning, Budget and Management, as well as the Court of Accounts	Direct observation and documentary analysis	The model responds to the paradigm that the sustainable product is necessarily more expensive. This research shows how to optimize the use of budgetary, human, logistical resources and information technology of MPF, with emphasis on quality and durability in contracting
Eikelboom, M. E., Gelderman, C., & Semeijn, J. (2018)	2002-2013	283 procurement professionals, out of which 119 project managers; 29 auction managers; 128 system engineers and seven managers	Structured equation modeling (SEM analysis)	Negative relationship between the lack of organizational support and the public procurement of sustainable innovation ($\beta = 0.237$; $p < 0.05$). Positive relationship between individual innovativeness and sustainable public procurement ($\beta = 0.264$; $p < 0.05$). Positive relationship between public procurement of sustainable innovation ($\beta = 0.261$; $p < 0.05$). Negative relationship for the regulatory complexity of sustainable public procurement ($\beta = -0.101$; $p = -0.212$)
Gustavsson, T., Kadefors, A., Lingegård, S., Laedre, O., Klakegg, O., Olsson, N. and Larsson, J. (2019)	2010-2018	Published license reports and doctoral theses in Norway and Sweden, found in the DIVA (in Sweden) and Cristin (in Norway) databases	Direct observation and documentary analysis	In Sweden the large number of universities carrying out research is a potential for a strong education in the field of construction procurement, as well as the multitude of infrastructure investment projects. Research in Norway has developed profound knowledge about the context of project

				procurement
Haugbølle, K., & Raffnsøe, L. M. (2019)	2013-2017	21 certified office buildings in Denmark according to the DGNB sustainable certification scheme and 8 LEED certified schools in the USA	Net present value (VNV) method	Construction and operation costs make up about half of the life cycle costs over a 50-year period, as well as the life-cycle costs for cleaning are about twice as high as the costs of energy and water supply
Landale, K., Rendon, R. and Hawkins, T. (2017)	1999-2015	124 public procurement contracts related to the US Air Force and the US Army, of which 80% with a value of more than 1 million USD; of these contracts, 69 recorded supplier performance evaluations and 116 recorded purchasing team dimensions	Multiple regression, covariance analysis	Each method has its advantages and disadvantages; but, so far, research has not explored the links between source selection methods and key procurement outcomes. However, the TO method results in better supplier performance.
Migdadi, Y. K. A. A., & Omari, A. A. (2019)	1999-01.05.2019	25 cases from around the world were considered, based on the annual sustainability reports, taken from the Global Reporting Initiative (GRI) database.	Method of comparative evaluation and quantitative analysis of the content of sustainability reports	Four major taxes of green operation strategy in hospitals were: resources/waste management; electrical power management; non-hazardous waste management; and emissions/resources management, and the final conclusion was that countries around the world should respect the new regulations for their environmental footprint
Wang, W., Zhang, S. and Pasquire, C. (2018)	April 2 - May 27, 2017	300 professionals from China randomly selected for the survey; 128 valid questionnaires out of which 27% were managers and 73% engineers; of these 18% (more than 20 years' experience), 39% (between 10-20 years' experience), and 27% (5-10 years' experience)	Average scoring method and factor analysis	By analyzing the factors, the 18 basic critical variables are classified into five factors: technology and green techniques; awareness and attitude; government policies and regulations; market demand; and economy. The results show that solutions to overcome China's barriers are largely dependent on the government
Zhu, Q., Sarkis, J. and Lai, K. (2019)	2001-2016	China, Japan, Germany, Canada surveys, as well as site visits and interviews with manufacturers, as well as key stakeholders of GSCM, such as governments, ONG's and researchers	Method of survey and interview	A key LCA-based approach, GSCM, can be useful for companies to initiate appropriate GSCM practices to gain opportunities and avoid risks. To effectively implement GSCM practices, a company should understand the life cycle of its product and its position in the supply chain
Zipperer, V. (2019)	2006-2016	Data from a German company regarding green public procurement contracts, where information about the company's characteristics can be found, in terms of innovation; 5374 individual companies of which 46% innovated	Empirical analysis	H1: There is no significant relationship between demand-attracting innovations; H2: There is a significant relationship between winning a green public procurement contract and the probability of producing product innovations; H3: It is confirmed that the effect of reducing demand for green public procurement on general innovations differs between sectors

Source: Authors' work based on literature review

III. RESEARCH METHODOLOGY

In this paper, we approach two data types of indicators. Due to the limited source of ecology data, we focused on selecting several indicators that exemplify the expenditures allocated for various functions. Regarding the macroeconomic part of the study, we decided that the gross domestic product is a key indicator of a country (it provides information on the level of development of a country).

Table no 2. Variables' description

Variables	Description	Period	Source
General government expenditure by function			
EP	**Environmental protection**		Eurostat
WM	**Waste management**	1995-2017	Eurostat
PA	**Pollution abatement**	1995-2017	Eurostat
PBL	**Protection of biodiversity and landscape**	1995-2017	Eurostat
RDEP	**R&D Environmental protection**	1995-2017	Eurostat
Variables regarding GDP and main aggregates			
GDP	**Gross domestic product at market prices**	1995-2017	Eurostat
FCE	**Final consumption expenditure of general government**	1995-2017	Eurostat

Source: Authors' work

It should not be ignored that the level of public spending represents what can be considered an indicator of effort of the respective country in developing the economy. We selected environmental protection, waste management, pollution abatement, protection of biodiversity and landscape, R&D environmental protection. The

quantitative study is based on annual data from 1995 until 2017.Data sources is Eurostat. The selected variables, alongside their definitions, period, and source, are exhibited in Table no 2.

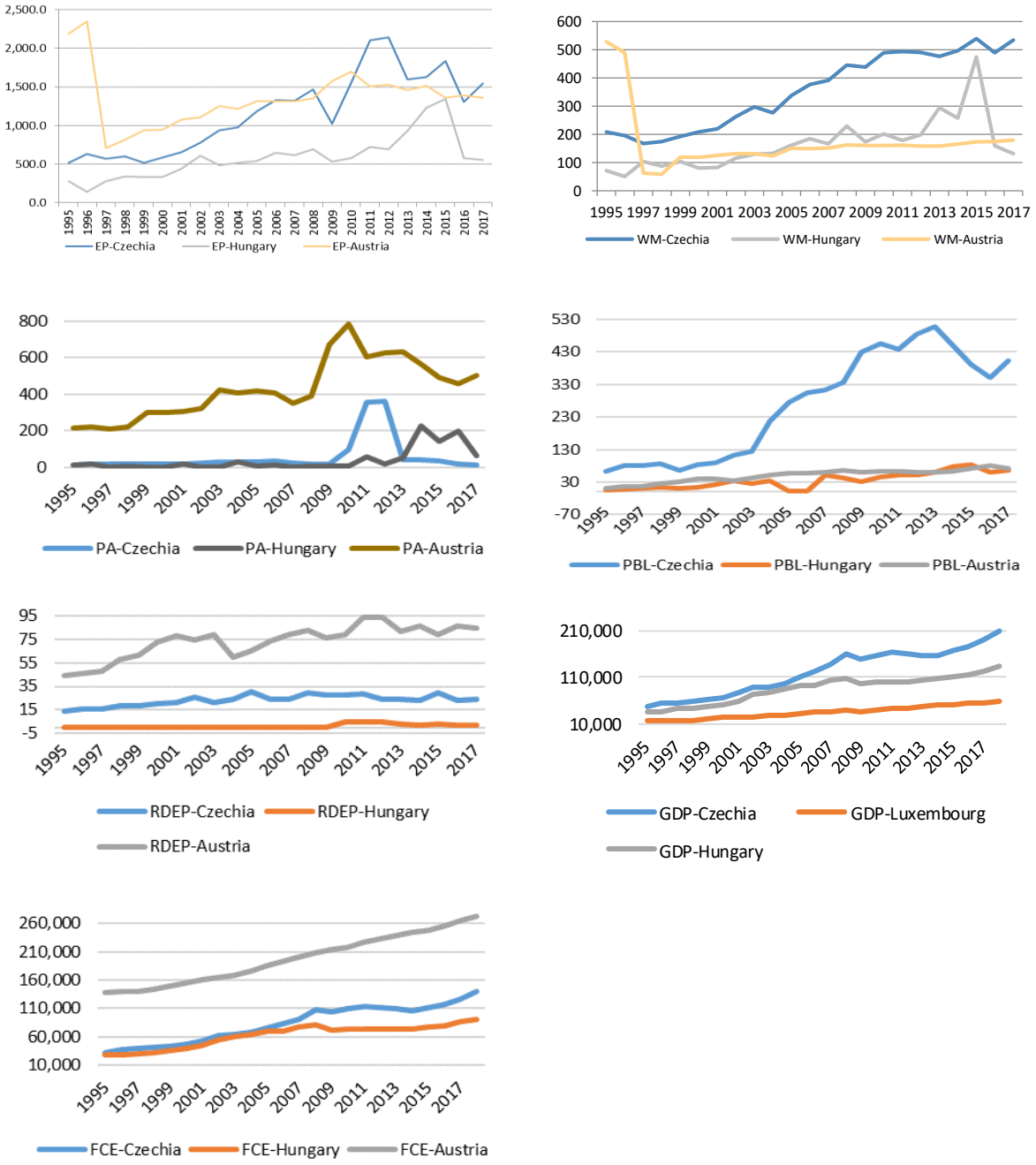

Figure no. 1: Evolution of indicators for the period 1995-2017

The evolution of the seven variables for the period 1995-2017, selected in our study can be found in figure 1. Most of the variables show an upward trend, but in the case of Hungary in the last 2-3 years, there is a decrease of the expenses regarding environmental protection, waste management and pollution abatement. In this article, we intend to study the relationship between the costs related to ecology and GDP, final consumption expenditure. In order to reach a relevant conclusion, we will apply several econometric models.

One of the first steps in econometric analysis is to test for the unit roots of the series. For the purposes of this paper, the augmented Dickey–Fuller (ADF) unit root test will be employed to check the non-stationary assumption. The ADF test involves estimating the equation:

$$\Delta y_t = \alpha + \beta t + q y_t + \sum_{j=1}^{k} \gamma_j \Delta y_{t-j} + \varepsilon_t, \quad t=1,\ldots,T \qquad (1)$$

where t is a time trend, T = length sample, and k measures the length of the lag in the dependent variable. The null hypothesis supposes that the variable has a unit root, and the alternative is that the variable was generated by a stationary process.

The estimated multiple regression looks like this:

$$GDP_{country} = a + a_1 EP_{country} + a_2 WM_{country} + a_3 PA_{country} + a_4 PBL_{country} + a_5 RDEP_{country} + a_6 FCE_{country} \quad (2)$$

Where a_i represent the coefficients of the terms and i=1,6.

The purpose of multiple regression (term used by Pearson, 1908) is to highlight the relationship between a dependent variable (explained, endogenous, resultant) and a lot of independent variables (explanatory, factorial, exogenous, predictive). According to the literature, to analyze the causality between two variables, the Granger causality test can be used. The null hypothesis is that x does not Granger-cause y in the first regression and that y does not Granger-cause x in the second regression. We have the following bivariate regressions:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \cdots + \alpha_p y_{t-p} + \beta_1 x_{t-1} + \cdots + \beta_p x_{-p} + \epsilon_t \quad (3)$$

$$x_t = \alpha_0 + \alpha_1 x_{t-1} + \cdots + \alpha_p x_{t-p} + \beta_1 y_{t-1} + \cdots + \beta_p y_{-p} + u_t \quad (4)$$

IV. RESULTS AND DISCUSSION

Table no.3 contain the descriptive statistics of the variables. The skewness indicator is used to analyze the distribution of a series of data to indicate the deviation in relation to a symmetric distribution around the average. The Kurtosis indicator is used in the analysis of the distribution of a series of data to indicate the degree of flattening or sharpening.

Table no 3. Descriptive statistics of the variables

	EP_AUSTRIA	EP_CZECHIA	EP_HUNGARY	FCE_AUSTRIA	FCE_CZECHIA	FCE_HUNGARY	GDP_AUSTRIA	GDP_CZECHIA	GDP_HUNGARY
Mean	1321.923	1193.855	596.6591	197141.6	82695.89	62124.14	270389.8	120736.9	84269.32
Median	1332.200	1247.150	565.8500	197523.1	86936.95	70609.20	275901.3	131123.0	93027.25
Maximum	2344.800	2139.000	1340.600	264656.7	127693.9	86505.80	369899.2	191721.8	124050.3
Minimum	710.0000	512.7000	143.5000	139693.8	36551.60	27441.10	186968.1	52771.30	36759.20
Std. Dev.	340.2525	504.9232	281.2373	40731.70	30421.21	18734.90	57393.25	46225.47	26587.07
Skewness	0.825792	0.258108	1.137175	0.081650	-0.206415	-0.731817	0.075944	-0.178987	-0.530258
Kurtosis	5.123516	1.997506	4.342836	1.668991	1.504880	2.053029	1.767607	1.507934	1.947629
JB	6.633966	1.165516	6.394550	1.648399	2.205328	2.785732	1.413374	2.158205	2.046164
Probability	0.036262	0.558356	0.040873	0.438586	0.331985	0.248363	0.493276	0.339900	0.359485

	PA_AUSTRIA	PA_CZECHIA	PA_HUNGARY	PBL_AUSTRIA	PBL_CZECHIA	PBL_HUNGARY	PPBL_CZECHIA	RDEP_CZECHIA	RDEP_HUNGARY
Mean	438.1136	59.00000	41.18636	52.04545	276.5227	36.91364	15.45909	23.72727	1.227273
Median	415.4000	24.40000	11.20000	59.10000	309.6500	34.80000	16.55000	23.60000	0.050000
Maximum	786.4000	363.3000	230.3000	82.10000	507.6000	82.60000	93.20000	30.60000	4.600000
Minimum	208.5000	14.90000	0.100000	16.80000	67.60000	1.600000	-58.40000	15.50000	0.000000
Std. Dev.	158.6389	98.92051	64.89010	18.35034	159.1297	24.56475	39.80869	4.255213	1.753413
Skewness	0.424444	2.703593	1.979057	-0.533253	-0.104712	0.203937	0.018756	-0.196194	0.956576
Kurtosis	2.355771	8.566976	5.668174	2.284681	1.436267	1.906690	2.939462	2.371669	2.313092
JB	1.041004	55.20980	20.88700	1.511689	2.281692	1.248214	0.004649	0.503038	3.787660
Probability	0.594222	0.000000	0.000029	0.469614	0.319549	0.535740	0.997678	0.777619	0.150494

	WM_AUSTRIA	WM_CZECHIA	WM_HUNGARY
Mean	157.6455	363.4591	168.1727
Median	155.0500	384.5000	160.4500
Maximum	489.9000	539.5000	474.2000
Minimum	58.40000	168.0000	51.20000
Std. Dev.	80.77149	132.2260	91.15176
Skewness	3.204521	-0.191428	1.766853
Kurtosis	14.50154	1.463278	6.865251
JB	158.9144	2.299087	25.14165
Probability	0.000000	0.316781	0.000003

Source: Authors' work

The variables that presents a negative Skewness values reflect an asymmetric distribution to the left, and the ones with positive values presents a distributions with asymmetry to the right. The kurtosis of EP_AUSTRIA, EP_HUNGARY, PA_CZECHIA, PA_HUNGARY and WM_AUSTRIA exceeds 3, so the distribution is leptokurtic and for the rest of the series the kurtosis is less than 3, the distribution is flat relative to the normal. The Jarque-Bera test statistic is used for testing whether the series is normally distributed. The null hypothesis of a normal distribution is rejected at the 5% significance level, with the exception for the following

indicators WM_AUSTRIA, WM_HUGARY, PA_HUNGARY, PA_ CZECHIA and EP_AUSTRIA that present a normal distribution.

The next step in our research is choosing the number of lags. The number of delays can be chosen by studying the information criteria. The information criteria are the initial measures that can be taken when selecting the appropriate "delay length" over a series of time. Following the application of the Lag Length Criteria we decided to use lag 1 for the following tests.Data stationarity has been tested by applying the Augmented Dickey-Fuller test (ADF). The test results can be found in Table 3.

Table no 4. The outcomes of Augmented Dickey-Fuller test

Variables	Level	First Difference	Second Difference
EP_AUSTRIA	-3.332013	-	-
FCE_AUSTRIA	1.035242	-3.980350	-
GDP_AUSTRIA	1.431727	-4.024826	-
PA_AUSTRIA	-1.516112	-4.544550	-
PBL_AUSTRIA	-1.706184	-3.254389	-
RDEP_AUSTRIA	-2.101676	-5.029356	-
WM_AUSTRIA	-16.66790	-4.065589	-
EP_CZECHIA	-1.468388	-4.573937	-
FCE_CZECHIA	0.063491	-3.580602	-
GDP_CZECHIA	0.137802	-3.920466	-
PA_CZECHIA	-3.080298	-	-
PBL_CZECHIA	-1.006642	-2.945078	-3.787970
RDEP_CZECHIA	-2.619682	-5.823980	-
WM_CZECHIA	-0.342038	-5.597662	-
EP_HUNGARY	-1.942088	-4.093256	-
FCE_HUNGARY	-1.058295	-3.818031	-
GDP_HUNGARY	-0.505968	-4.307399	-
PA_HUNGARY	-2.181034	-6.666309	-
PBL_HUNGARY	-0.369305	-5.737641	-
RDEP_HUNGARY	-1.488897	-4.435585	-
WM_HUNGARY	-0.396175	-5.112134	-

Source: Authors' work

Most variables have an order of integration of I (1), which means that they are only the first difference station. However, we also have an indicator that becomes stationary only at the second differentiation, Protection of biodiversity and landscape for Czech Republic. We mention that we also have series of data already stationary such as Environmental protection for Austria and Pollution abatement for Czech Republic. The table no.4 shows results obtained after estimating multiple equations for the case Austria.

Table no 5. The regression results for Austria

Dependent Variable: **DGDP_AUSTRIA**				
Method: Least Squares				
Sample (adjusted): 1996 2017				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DEP_AUSTRIA	0.560020	2.192506	0.255425	0.8019
DFCE_AUSTRIA	**1.275773**	0.331421	3.849405	**0.0016**
DPA_AUSTRIA	**-32.53259**	7.622706	-4.267853	**0.0007**
DPBL_AUSTRIA	-4.793481	113.0748	-0.042392	0.9667
DRDEP_AUSTRIA	18.50596	72.57962	0.254975	0.8022
WM_AUSTRIA	-7.542804	7.346356	-1.026741	0.3208
C	2670.228	2751.415	0.970493	0.3472
R-squared	0.824483	Mean dependent var		8433.995
Adjusted R-squared	0.754276	S.D. dependent var		4924.659
S.E. of regression	2441.179	Akaike info criterion		18.69172
Sum squared resid	89390311	Schwarz criterion		19.03887
Log likelihood	-198.6089	Hannan-Quinn criter.		18.77350
F-statistic	11.74365	Durbin-Watson stat		2.323282
Prob(F-statistic)	0.000062			

Source: Authors' work

In the case of Austria, the independent variables are not all statistically significant, except for pollution abatement and final consumption expenditure of general government whose probability is below 5%. There is a negative relationship between the expenditures for pollution abatement and GDP and a positive connection with the expenditure of general government. In the existing studies that analyzed the relation between expenditure and

GDP, they obtained a positive relationship. The coefficient of determination is R^2 = 82.44%, in this case 51% of GDP can be explained by the linear relationship with independent variables, in our case of pollution abatement and final consumption expenditure of general government.

According to the specialized literature, to analyze the causality between variables, the Granger causality test can be used. In order to be able to apply the Granger causality test, the data series must be stationary and the mean must be 0. In our case they are already stationary and we obtained the following results for the case country Austria, which are shown in table no.6

Table no 6. The results of the Granger causality test for Austria

Null Hypothesis:		F-Statistic	Prob.
DFCE_AUSTRIA does not Granger Cause DGDP_AUSTRIA		0.09660	0.7593
DGDP_AUSTRIA does not Granger Cause DFCE_AUSTRIA		1.28133	0.2717
DEP_AUSTRIA does not Granger Cause DGDP_AUSTRIA		0.00614	0.9384
DGDP_AUSTRIA does not Granger Cause DEP_AUSTRIA		1.01687	0.3266
DPA_AUSTRIA does not Granger Cause DGDP_AUSTRIA		0.67001	0.4238
DGDP_AUSTRIA does not Granger Cause DPA_AUSTRIA		0.02592	0.8739
DPBL_AUSTRIA does not Granger Cause DGDP_AUSTRIA		0.45947	0.5065
DGDP_AUSTRIA does not Granger Cause DPBL_AUSTRIA		0.83525	0.3728
DRDEP_AUSTRIA does not Granger Cause DGDP_AUSTRIA		0.20055	0.6596
DGDP_AUSTRIA does not Granger Cause DRDEP_AUSTRIA		0.09977	0.7557
WM_AUSTRIA does not Granger Cause DGDP_AUSTRIA		1.49154	0.2377
DGDP_AUSTRIA does not Granger Cause WM_AUSTRIA		4.34507	0.0516

Source: Authors' work

Of all the indicators we have chosen as being representative for the Austrian market no causal relationships were identified.

Table no 7. The regression results for Czech Republic

Dependent Variable: **DGDP_CZECHIA**				
Method: Least Squares				
Sample (adjusted): 1997 2017				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DFCE_CZECHIA	**1.446309**	0.156195	9.259646	**0.0000**
DEP_CZECHIA	4.608916	3.808831	1.210061	0.2463
DPBL_CZECHIA	-13.14949	14.02106	-0.937839	0.3642
DRDEP_CZECHIA	55.92554	186.8966	0.299232	0.7692
DWM_CZECHIA	-22.98540	32.47298	-0.707831	0.4907
PA_CZECHIA	-2.498665	8.074318	-0.309458	0.7615
C	662.4466	1146.447	0.577826	0.5726
R-squared	0.920910	Mean dependent var		6616.690
Adjusted R-squared	0.887014	S.D. dependent var		8001.937
S.E. of regression	2689.726	Akaike info criterion		18.89347
Sum squared resid	1.01E+08	Schwarz criterion		19.24164
Log likelihood	-191.3814	Hannan-Quinn criter.		18.96903
F-statistic	27.16877	Durbin-Watson stat		1.148168
Prob(F-statistic)	0.000001			

Source: Authors' work

Like in Austria, in the case of the Czech Republic, a positive relationship is identified between final consumption expenditure of general government and GDP. The coefficient of determination is around 90%, higher in this case, thus explaining the variation of GDP in the Czech Republic in a higher weight. Regarding Granger causality, this was not found in the case of the Czech Republic either.

Table no 8. The results of the Granger causality test for Czech Republic

Null Hypothesis:		F-Statistic	Prob.

DFCE_CZECHIA does not Granger Cause DGDP_CZECHIA	3.32978	0.0838
DGDP_CZECHIA does not Granger Cause DFCE_CZECHIA	2.30092	0.1458
DEP_CZECHIA does not Granger Cause DGDP_CZECHIA	0.58523	0.4542
DGDP_CZECHIA does not Granger Cause DEP_CZECHIA	1.40757	0.2509
DPBL_CZECHIA does not Granger Cause DGDP_CZECHIA	0.23471	0.6342
DGDP_CZECHIA does not Granger Cause DPBL_CZECHIA	2.70494	0.1184
DRDEP_CZECHIA does not Granger Cause DGDP_CZECHIA	1.39162	0.2535
DGDP_CZECHIA does not Granger Cause DRDEP_CZECHIA	0.19462	0.6644
DWM_CZECHIA does not Granger Cause DGDP_CZECHIA	0.22080	0.6441
DGDP_CZECHIA does not Granger Cause DWM_CZECHIA	0.00545	0.9420
PA_CZECHIA does not Granger Cause DGDP_CZECHIA	3.13901	0.0934
DGDP_CZECHIA does not Granger Cause PA_CZECHIA	0.04496	0.8345

Source: Authors' work

The only statistical significant coefficient of multiple equations estimated for Hungary is final consumption expenditure of general government. A positive relationship is identified between these two variables. Thus, in all the analyzed countries, a positive connection between expenditure and GDP is confirmed, a fact confirmed by existing results in specialized literature.

Table no 9. The regression results for Hungary

Dependent Variable: **DGDP_HUNGARY**				
Method: Least Squares				
Sample (adjusted): 1996 2017				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DFCE_HUNGARY	**1.261061**	0.083647	15.07600	**0.0000**
DEP_HUNGARY	2.871653	3.109599	0.923480	0.3704
DPA_HUNGARY	3.139166	7.557835	0.415353	0.6838
DPBL_HUNGARY	21.09959	23.34319	0.903887	0.3803
DRDEP_HUNGARY	208.6244	300.8516	0.693446	0.4986
DWM_HUNGARY	-0.832024	7.299821	-0.113979	0.9108
C	507.0547	371.8335	1.363661	0.1928
R-squared	0.950221	Mean dependent var		4026.641
Adjusted R-squared	0.930309	S.D. dependent var		5263.716
S.E. of regression	1389.572	Akaike info criterion		17.56475
Sum squared resid	28963664	Schwarz criterion		17.91190
Log likelihood	-186.2123	Hannan-Quinn criter.		17.64653
F-statistic	47.72162	Durbin-Watson stat		1.439222
Prob(F-statistic)	0.000000			

Source: Authors' work

In the case of Hungary, there was a unidirectional causal relationship between the gross domestic product towards R&D Environmental protection. The other variables have no causality.

Table no 10. The results of the Granger causality test for Hungary

Null Hypothesis:	F-Statistic	Prob.
DFCE_HUNGARY does not Granger Cause DGDP_HUNGARY	0.09173	0.7653
DGDP_HUNGARY does not Granger Cause DFCE_HUNGARY	0.08228	0.7773
DEP_HUNGARY does not Granger Cause DGDP_HUNGARY	1.68519	0.2106
DGDP_HUNGARY does not Granger Cause DEP_HUNGARY	0.38077	0.5449
DPA_HUNGARY does not Granger Cause DGDP_HUNGARY	0.22084	0.6440
DGDP_HUNGARY does not Granger Cause DPA_HUNGARY	0.03729	0.8490
DPBL_HUNGARY does not Granger Cause DGDP_HUNGARY	0.29241	0.5953
DGDP_HUNGARY does not Granger Cause DPBL_HUNGARY	3.74600	0.0688
DRDEP_HUNGARY does not Granger Cause DGDP_HUNGARY	0.21286	0.6501
DGDP_HUNGARY does not Granger Cause DRDEP_HUNGARY	12.0198	**0.0028**

DWM_HUNGARY does not Granger Cause DGDP_HUNGARY	2.56717	0.1265
DGDP_HUNGARY does not Granger Cause DWM_HUNGARY	2.5E-05	0.9961

Source: Authors' work

V. CONCLUSION

The main objective of this study is to investigate the link between economic growth and environmental protection for countries: Austria, Czech Republic and Hungary. Form the economic growth we used gross domestic products (GDP) as a proxy and for the environmental protection we decided to use general government expenditure by function such as: environmental protection, waste management, pollution abatement, protection of biodiversity and landscape and R&D environmental protection. Due to the restrictions in finding the data, we decided that the period under investigation would be 1995-2017.

In this article, we intend to study the relationship between the costs related to ecology and GDP, final consumption expenditure. In order to reach a relevant conclusion, we will apply stationary test, estimate multiple regression and apply the Granger causality test. The empirical results confirmed the presence of a positive link between GDP and expenditures for Austria, Czech Republic and Hungary, a fact confirmed by the other existing studies. The Granger causality test confirmed the presence of a unidirectional causality from GDP to R&D Environmental protection only in the case of Hungary.

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