



Public Expenditure on Environmental Protection in the European Union Countries

*Tomasz Rokicki^{*1}, Luiza Ochnio¹, Grzegorz Koszela¹, Agata Żak²,
Edyta Karolina Szczepaniuk³, Hubert Szczepaniuk¹, Konrad Michalski¹,
Aleksandra Perkowska¹*

¹*Warsaw University of Life Sciences WULS – SGGW, Poland*

²*Institute of Agricultural and Food Economics
– National Research Institute, Poland*

³*Polish Air Force University, Poland*

**corresponding author's e-mail: tomasz_rokicki@sggw.pl*

1. Introduction

Care for the natural environment should be the domain of every human being and business entity. However, enterprises appreciate the maximization of profits, and paying the attention to the environment is on the second place. The role of the state and international organizations is to regulate environmental protection by creating appropriate regulations. Legal acts force people and enterprises to act as little as possible to harm the environment. Individual countries are also actively involved in securing the environment, allocating funds for this purpose in their budget. The scale of expenses depends on the possibilities and needs. Public expenditure should stimulate beneficial changes in environmental protection in many aspects (Portney 1990, Rokicki et al. 2018). The article presents the directions and strength of changes that are taking place in this area in EU countries.

In accordance with the Classification of Environmental Protection Activities and Expenditure (2000) nine fields of environmental protection can be distinguished. Expenses are generated in each of them. The list of fields is as follows:

- Protection of ambient air and climate,
- Wastewater management,
- Waste management,
- Protection and remediation of soil, groundwater and surface water,

- Noise and vibration abatement (excluding workplace protection),
- Protection of biodiversity and landscapes,
- Protection against radiation (excluding external safety),
- Research and development,
- Other environmental protection activities.

The fields also include categories and subcategories.

2. Literature review

The increased importance of environmental protection in people's awareness has also led to the need to count cash flows in this area. For the first time, economists became interested in the environment in the 1970s (Ruff 1970, Baumol & Oates 1971, Mills 1978, Baram 1979, Loehman et al. 1979). In the following years, the idea of economic accounts, valuation of expenditures and costs related to environmental protection were developed (Ellis & Fisher 1986, Hazilla & Kopp 1990, Zhu & ReVelle 1990). An important issue was the inclusion of the environment in national accounts. It was found that the interaction between the economy and the environment is so important that a tool should be created that would show this interaction. Thus, environmental economic accounts were created, which are satellite accounts in relation to national accounts. In the European Union, these issues have been regulated by relevant regulations (Regulation (EU) No. 691/2011, Regulation (EU) No. 538/2014).

It is necessary to distinguish the concepts of environmental protection costs and expenses for this purpose. The term costs is often used at the enterprise level and the term expenses at the macroeconomic level. Expenses refer to the actual cash input, while the cost is not necessarily related to the input (Environmental... 2005). Environmental costs arise as a result of statutory or voluntary actions aimed at preventing, limiting, and neutralizing waste, as well as taking into account the adverse effects of the lack of environmental actions to protect the environment. They include economic and social costs of environmental protection, often difficult to evaluate (Dimitroff-Regatschnig et al., 2002). Expenditure on environmental protection, on the other hand, means economic resources devoted to environmental protection by resident units. Environmental protection covers all types of activities and actions which main purpose is to reduce and eliminate pollution and other forms of environmental degradation, as well as to prevent these phenomena. These activities and actions cover all funds spent to restore a degraded environment (Regulation (EU) No. 538/2014). Referring to this definition, public expenses on environmental protection are the domain of state authorities at various levels.

In the 1980s, the importance of expenditures on environmental protection was low. Governments focused rather on creating conditions for the development of the economy, including industry. Environmental protection was in opposition to these goals (Gillroy & Shapiro 1986). However, environmental protection quickly became a global problem (Barrett 1990). Regulations favoring the preservation of the environment and preventing its degradation were introduced (Hahn & Stavins 1992). Gradually, environmental protection grew in importance, which was also reflected in the increase in spending for this purpose (Dunlap & Scarce 1991). The problem was still the low economic effectiveness of environmental protection expenditures and the devaluation of social benefits (Pearce 1998). Nowadays, care for environmental protection has become a standard. Enterprises apply pro-active environmental management under the influence of government, investors and consumers. As the research results show, such activity ultimately favors the increase of productivity and competitiveness of enterprises (Berry & Rondinelli 1998). In developed countries, the economic impact of economic growth on emissions is significantly different. Diversified income generates a gap between the ability and willingness of a given country to pay for environmental protection (Magnani 2000, Rokicki 2016). A methodology for counting expenses for environmental protection was also developed. By this means, it is possible to compare such expenses in various countries and enterprises. Such accounts do not include external costs (environmental and social) (Jasch 2003, Soukopová & Struk 2011). The analysis of environmental protection expenditures is of strategic importance and allows the assessment of existing environmental policies. A low level of expenditure does not always mean that the country does not effectively protect its environment. Expenditure is often associated with reduction of adverse effects on nature, reduction of pollutant emissions or application of more effective protection measures (Broniewicz 2004, Georgescu & Cabeca 2010, Rokicki 2017).

3. Aim, materials and methods

The main goal of the paper is to show the level of public spending on environmental protection in the European Union countries. The specific objectives are: to present the variation in expenses on environmental protection in the EU countries, to determine their significance in the total expenditure of countries, to show the dynamics of changes in expenditure on environmental protection, to identify factors correlated with the level of environmental protection expenses. The paper presents a hypothesis that the level of public expenses on environmental protection in the EU countries was correlated with the economic situation. All European Union member states were selected for research stated by day December 31, 2017 (28 countries). The research period concerned the years 2004-2017. The sources of materials were EUROSTAT data and the literature of the subject. For

analysis and presentation of materials, the following methods were used: descriptive, tabular, graphical, fixed-rate dynamics indicators, Gini concentration coefficient, concentration analysis using the Lorenz curve, density diagram (nuclear estimator), Pearson's linear correlation coefficients.

The dynamics indicators with a fixed base are determined as follows (Starzyńska 2002):

$$i = \frac{y_n}{y_0} \quad \text{or} \quad i = \frac{y_n}{y_0} \cdot 100\% \quad (1)$$

where :

y_n – the level of the phenomenon in a certain period,

y_0 – the level of the phenomenon during the reference period.

The Gini coefficient is a measure of concentration (unevenness) of distribution of a random variable. If the observations y_i are sorted in ascending order, the coefficient can be presented by the formula (Dixon et al. 1987, Damgaard & Weiner 2000):

$$G(y) = \frac{\sum_{i=1}^n (2i - n - 1) * y_i}{n^2 * \bar{y}} \quad (2)$$

where:

n – number of observations

y_i – value of the “i-th” observation,

\bar{y} – the average value of all observations, i.e. $\bar{y} = \frac{1}{n} \sum_{i=1}^n y_i$

The Lorenz curve determines the degree of concentration of a one-dimensional distribution of a random variable (Dagum 1980). With sorted observations y_i , which are non-negative values $0 \leq y_1 \leq y_2 \leq \dots \leq y_n$, $\sum_{i=1}^n y_i > 0$, the Lorenz curve is a polyline which apexes (x_h, z_h) , for $h = 0, 1, \dots, n$, have the following coordinates:

$$x_0 = z_0 = 0, \quad x_h = \frac{h}{n}, \quad z_h = \frac{\sum_{i=1}^h y_i}{\sum_{i=1}^n y_i} \quad (3)$$

The Gini coefficient determines the area between the Lorenz curve and the diagonal of a unit square multiplied by 2.

In the case of a nuclear density estimator, the nucleus is such a function $K : \mathbb{R} \rightarrow [0, \infty]$ that (Kulczycki 2005):

$$1) \int_{-\infty}^{\infty} K(x)dx = 1$$

2) $K(0) \geq K(X)$ for each R

3) K – symmetrical to zero.

A nuclear estimator is a function $\hat{f}_n(x) = \frac{1}{nh} \sum_{i=1}^n K\left(\frac{X - X_i}{h}\right)$, (4) where h is a constant called a bandwidth for $h > 0$.

The Doornik-Hansen test was used to determine compliance with the normal distribution (1994):

$$DH = z_1^2 + z_2^2 \quad (5)$$

where:

z_1 – transformed skewness,

z_2 – transformed oddity.

Pearson's linear correlation coefficient is a measure of the strength of a straight line relationship between two measurable features. It is expressed by means of the following formula (Jajuga & Walesiak 2004):

$$r_{XY} = \frac{C(X, Y)}{\sqrt{S_X^2 \cdot S_Y^2}} = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2 \cdot \sum_{i=1}^n (y_i - \bar{y})^2}} = \frac{C(X, Y)}{S_X \cdot S_Y} \quad (6)$$

where:

$C(X, Y)$ – covariance between the X and Y features,

S_X^2 – X feature variance,

S_Y^2 – Y feature variance,

S_X – X feature's standard deviation,

S_Y – Y feature's standard deviation.

The linear correlation coefficient can be treated as normalized covariance. Correlation always takes values in the range $(-1, 1)$.

4. Research results

Public expenses on environmental protection in the EU in 2005-2017 increased by 16% (Table 1). At that time, individual countries were developing economically, so an increase in this type of spending was beneficial for the environment. In the analyzed period, in most countries there was an increase in public spending on environmental protection, the largest in Romania (by 279%) and Croatia (by 158%). A decrease in this type of expenditure was recorded only in a few countries, i.e. United Kingdom and Ireland (40% each), Slovenia (18%), Finland (12%) and Denmark (10%). Among the countries with the largest public expenditure for environmental protection, only in United Kingdom there was a decrease. This may be due to changes in the government's policy in this country or the allocation of budgetary resources to other competing goals. The group of countries with the largest public expenses for environmental protection included mainly countries from Western Europe.

Table 1. Total public expenditures on environmental protection in EU countries in 2005-2017 (EUROSTAT)

Countries	Public expenditures for environmental protection in EU countries (years)					Dynamics of changes 2017/2005
	2005	2008	2011	2014	2017	
France	15326	17796	20406	21995	21699	141.58
Germany	12612	13098	15796	17689	20672	163.91
United Kingdom	27669	17022	16756	18363	16738	60.50
Italy	11933	13235	14455	15302	15603	130.76
Netherlands	8477	9948	10105	9357	10148	119.71
Spain	8374	10884	10174	9096	10071	120.27
Belgium	2422	2857	4463	4033	4014	165.77
Greece	1177	2199	1749	2629	2860	242.99
Poland	1598	2402	2620	2542	1814	113.48
Czechia	1186	1465	2104	1629	1542	130.02
Sweden	1185	1176	1319	1338	1479	124.78
Austria	1311	1350	1505	1514	1363	103.96
Denmark	1327	1100	951	1234	1192	89.84
Portugal	958	1144	1209	987	1100	114.79
Romania	256	702	1241	1197	968	378.94
Ireland	1603	2137	1243	987	950	59.28
Hungary	540	694	723	1229	680	125.93
Slovakia	332	521	548	641	610	183.95
Luxembourg	345	433	470	452	549	159.48
Finland	517	594	480	521	453	87.62

Table 1. cont.

Countries	Public expenditures for environmental protection in EU countries (years)					Dynamics of changes 2017/2005
	2005	2008	2011	2014	2017	
Bulgaria	168	252	284	295	351	208.49
Croatia	120	173	153	162	310	257.90
Slovenia	236	294	294	370	194	82.36
Estonia	103	173	-47	130	177	171.48
Lithuania	123	275	232	206	175	142.51
Latvia	94	202	138	161	152	160.49
Malta	74	94	88	126	105	142.12
Cyprus	43	52	61	46	50	116.28
EU 28	100107	102271	109518	114229	116019	115.89

Public expenses on environmental protection in 2005-2017 accounted for about 1.6-1.7% of all public expenses in the entire EU. There were differences in individual countries. The lowest shares of this type of expenses were in Romania in 2005 and in Finland in 2011-2017 (around 0.4% in the structure of public expenses in these countries). The greatest importance of this type of expenses was in the budget of Malta in 2010 (4.7%). In general, in Western European countries, especially the most economically developed, the share of public expenses on environmental protection in total government expenditure was at a level close to the EU average. Greater funds from national budgets are allocated for defense, public order and safety, economic affairs.

An interesting indicator is also the share of public expenses on environmental protection in GDP. In the analyzed years, it amounted to 0.7-0.9% in the EU. The lowest share was recorded in Finland in 2011-2012 and in 2015-2017 (0.2% of GDP), and the highest in Malta in 2010 and 2015 (1.9%). The regularities were similar to the share of public expenses on environmental protection in total public spending.

Unevenness in the distribution of public expenses on environmental protection was also examined. To determine the degree of concentration of energy consumption in the European Union countries, the Gini coefficient was applied. The data concerned the beginning of the research period, namely the year 2005 and the final stage, i.e. 2017, and the number of observations was 28. The Gini coefficient for public expenditure on environmental protection in 2005 calculated from the sample was 0.73 and the estimated coefficient for the population 0.76. This means a very high concentration of public expenses on environmental protection in several EU countries. In the case of repeating the research for 2017, the results were slightly lower (coefficient from the sample = 0.70, and estimated for

the population = 0.73). Therefore, no significant changes occurred in the expenditure of this type distribution. In addition, public spending on environmental protection in 2017 is presented on the Lorenz concentration curve (Figure 1). Although there were changes in the value of total public expenditure for environmental protection, there were virtually no changes in the structure. The countries with the largest expenditure on environmental protection still had a dominant position. On the basis of the conducted research, it can be stated that public expenditure on environmental protection in the EU was characterized by high stability.

The largest amount of public funds for environmental protection was allocated in France, Germany, Great Britain and Italy, i.e. the largest EU economies. In the structure of public spending on environmental protection, the smallest countries were of lower importance. This is also confirmed by the density diagram (Figure 2). In 21 countries, which accounted for 75% of all countries, a maximum of EUR 3.6 billion was spent in 2017 (in total in this group of countries only EUR 17 billion was spent, which accounted for only 15% of total public expenses on environmental protection in the EU). The consumption of renewable energy was not in accordance with the normal distribution.

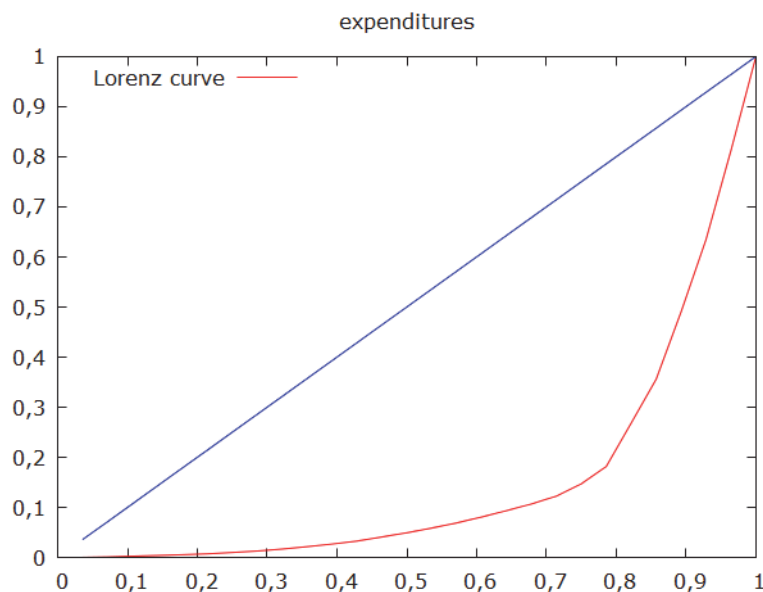


Fig. 1. Lorenz concentration curve for the public expenditures on environmental protection in EU countries in 2017

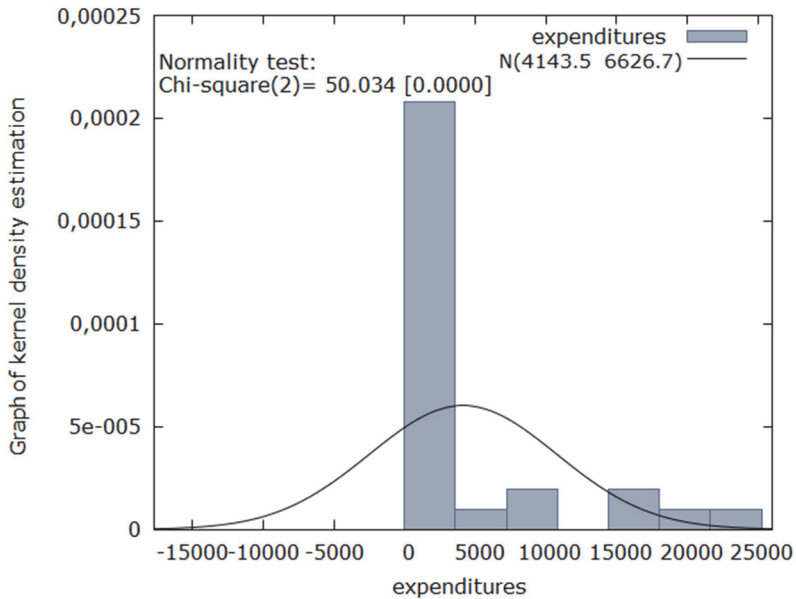


Fig. 2. Graph of kernel density estimation for public expenditure on environmental protection in EU countries in 2017

In order to find a connection between the value of public expenses on environmental protection in European Union countries and economic parameters that could be related, Pearson's linear correlation coefficients were calculated (Table 2). The $p = 0.05$ was assumed as the limit value of significance level. Significant results were marked with a gray background in the table. Correlation coefficients were calculated for EU countries in 2005-2017 and divided into periods of economic stabilization in 2005-2008, economic crisis in 2009-2010, crisis recovery and economic growth in 2011-2017. The paper tried to check the correlation, which does not indicate that a given factor affects another, only that there is a strong or weak relationship between them.

There were very strong positive associations of public expenses on environmental protection with the value of GDP and the value of exports and imports. This indicates a very large interdependence of the economic situation with the amount of funds allocated for environmental protection. Such regularities appeared irrespective of the period of research. During the economic crisis (2009-2010) they were stronger than during the stabilization period. It has already been shown that public expenditure on environmental protection was quite stable in relation to GDP.

Table 2. Pearson's linear correlation coefficients between public expenditures on environmental protection and selected economy parameters

Tested parameters	Pearson's linear correlation coefficients for years			
	2005-2008	2009-2010	2011-2017	2005-2017
Correlation coefficients between public expenditures on environmental protection and:				
GDP value in mln Euro	0.934	0.961	0.958	0.952
p value	0.001	0.001	0.001	0.001
GDP per capita in Euro	0.259	0.220	0.184	0.211
p value	0.006	0.103	0.010	0.001
Households consumption per capita in Euro	0.453	0.406	0.403	0.418
p value	0.001	0.002	0.001	0.001
Export value in mln Euro	0.831	0.873	0.869	0.855
p value	0.001	0.001	0.001	0.001
Import value in mln Euro	0.891	0.916	0.908	0.901
p value	0.001	0.001	0.001	0.001

The relation of expenditures on environmental protection and the level of household consumption per capita was also significant. The relationship was positive with medium strength. In the case of GDP per capita there were very weak dependencies. During the economic crisis, they proved irrelevant. The amount of public expenditure on environmental protection was interdependent from the economic situation of the country and the possibility of generating funds for various purposes important to society. The level of income per person was not an important factor in this case.

5. Conclusions

Today, public spending on environmental protection is a must. States must set the course of action and support pro-environmental solutions. The conducted research allowed to draw the following conclusions.

- 1 Public expenditure on environmental protection in EU countries has been systematically growing. There was a very high concentration of this type of expenditure in several EU countries. The situation was stable, because in the years 2005-2017 the concentration of expenses on environmental protection did not change significantly. The first four countries were the largest economically, namely France, Germany, Great Britain and Italy.
- 2 The significance of environmental protection expenditures in national budgets was low (more funds were allocated for other public purposes). However, there were differences between individual countries. In this case, the level of economic development was not decisive. Similar dependencies were in the

- case of public expenditure on environmental protection in GDP. In general, the situation in this respect was quite stable.
- 3 A significant relationship was found between the economic situation of the country and the value of public expenditure on environmental protection. The hypothesis of the paper was confirmed. Average positive relationships were found in the case of household consumption per capita, and very weak with GDP per capita. Parameters in calculation per capita were not suitable for determining interdependencies.
 - 4 The presented research allow to state that the level of public expenditure on environmental protection depends on the economic situation of the country. Bigger economies can afford greater support for pro-environmental ventures. The wealth of the society was not a decisive factor in the amount of support. In many countries, spending on environmental protection is an element of policy. Rulers are more likely to use public funds for purposes that give more visible effects and are economically effective. The issue of public spending is very important in the context of environmental protection.

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Abstract

The main objective of the paper was to show the level of public spending on environmental protection in the European Union countries. All European Union member states were selected for research purposefully. The research period concerned the years 2005-2017. The sources of materials were EUROSTAT data, literature of the subject. For the analysis and presentation of materials, descriptive, tabular and graphical methods, constant basis dynamics indicators, Gini concentration coefficient, concentration analysis using the Lorenz curve, density diagram (nuclear estimator), Pearson's linear correlation coefficients were used. Public spending on environmental protection is gradually becoming more and more accepted by the government, as evidenced by their systematic growth. There was a very high concentration of this type of expenditure in several EU countries. The first four countries were the largest economically, namely France, Germany, Great Britain and Italy. The importance of spending on environmental protection in national budgets was low, however, there were differences between countries. In this case, the level of economic development was not decisive. A significant relationship was found between the economic situation of the country and the value of public expenditure on environmental protection. On the other hand, parameters per person were not suitable for determining interdependencies. The wealth of the society was not a decisive factor in the amount of support. In many countries, spending on environmental protection is an element of policy. Rulers are more likely to use public funds for purposes that give more visible effects and are economically effective.

Keywords:

expenditure on environmental protection, EU, economic situation, environmental policy

Wydatki publiczne na ochronę środowiska w krajach Unii Europejskiej

Streszczenie

Celem głównym pracy było ukazanie poziomu wydatków publicznych na ochronę środowiska w krajach Unii Europejskiej. W sposób celowy wybrano do badań wszystkie kraje członkowskie Unii Europejskiej. Okres badań dotyczył lat 2005-2017. Źródłami materiałów były dane EUROSTAT, literatura przedmiotu. Do analizy i prezentacji materiałów zastosowano metody opisową, tabelaryczną, graficzną, wskaźniki dynamiki o podstawie stałej, współczynnik koncentracji Giniego, analiza koncentracji za pomocą krzywej Lorenza, wykres gęstości (estymator jądrowy), współczynniki korelacji liniowej Pearsona. Wydatki publiczne na ochronę środowiska stopniowo są coraz bardziej akceptowane przez rządzących, o czym świadczy ich systematyczny wzrost. Występowała bardzo duża koncentracja tego typu wydatków w kilku państwach UE. W pierwszej czwórce krajów były największe gospodarczo kraje, a więc Francja, Niemcy, Wielka Brytania i Włochy. Znaczenie wydatków na ochronę środowiska w budżetach krajowych było małe, występowały jednak różnice między poszczególnymi krajami. W tym przypadku poziom rozwoju gospodarczego nie był decydujący. Stwierdzono istotny związek między sytuacją gospodarczą kraju a wartością wydatków publicznych na ochronę środowiska. Z kolei parametry w przeliczeniu na osobę nie były odpowiednie do określenia współzależności. Zamożność społeczeństwa nie była czynnikiem decydującym o wysokości wsparcia. W wielu państwach wydatki na ochronę środowiska są elementem polityki. Rządzący chętniej przeznaczają środki publiczne na cele, które dają bardziej widoczne efekty i są efektywne ekonomicznie.

Słowa kluczowe:

wydatki na ochronę środowiska, UE, sytuacja gospodarcza, polityka ochrony środowiska