STATISTICAL STUDY ON THE CORRELATION BETWEEN "ENVIRONMENTAL PROTECTION EXPENDITURE" AND "AT RISK OF POVERTY RATE" IN THE EUROPEAN UNION, ROMANIA AND BULGARIA, 2015-2024

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Abstract

Through this paper we wanted to evaluate to what extent the efforts that society makes to improve environmental conditions are reflected in the well-being of the population. We put two indicators into the equation: "National expenditure on environmental protection" and "At-risk-of-poverty rate". "National expenditure on environmental protection" is the resources allocated to limit or remove the negative effects of economic activities. Expenditure on environmental protection includes the amounts of money allocated by various entities (government, companies or households) to reduce pollution (of any nature: air, water, soil), waste and wastewater management, protection of biodiversity, etc. The "at-risk-of-poverty rate" is an important indicator for assessing the well-being of a country's population. This article analyses the correlation between these indicators in the European Union, Romania and Bulgaria, in the period 2015-2024. In principle, financial efforts to protect the environment should have beneficial effects, i.e. contribute to poverty reduction. The calculations showed that there is an inverse relationship between the two indicators, that is, as environmental protection spending increases, there is a reduction in the risk of poverty, and vice versa (when environmental protection spending decreases, there is an increase in the risk of poverty), but this influence is quite small. There are, however, differences between the territorial units studied, in the sense that at the EU27 level the link is very weak, in Bulgaria it is weak, and in Romania it is of medium intensity.

Keywords: National expenditure on environmental protection, risk of poverty, statistics, correlation

JEL classification: C82, I32, O11, Q56

1. Introduction

In the study of the two indicators (Expenditure on environmental protection and Risk of poverty) we used several sets of data, which we took from Eurostat. I also consider it necessary to present the descriptions that the institutions that manage the statistical data make available to us.

Expenditure on environmental protection is the economic resources allocated to limiting pollution and environmental degradation, including operating expenditure and investment in environmental infrastructure.

„The Environmental Protection Expenditure Accounts (EPEA) measure the economic resources devoted to prevention, reduction, and elimination of pollution and any other degradation of the environment. They cover the spending by resident units of a country (i.e. by its households, corporations and government) on environmental protection (EP) services, e.g. pollution abatement (air, water, soil and noise), waste and wastewater management, protection of biodiversity as well as related research and development, education and training activities." [15]

„The environmental protection services are produced by both corporations and government and EPEA data are available broken down by institutional sector; data on production of environmental protection services by environmental domain (according to the classification of environmental protection activities (CEPA 2000), are also collected within EPEA and are available on the Eurostat database." [15]

„National expenditure on environmental protection (NEEP) measures the resources used by resident units in a given period for protecting the natural environment. It is calculated as a sum of current expenditure on environmental protection (EP) activities and investments for EP activities, including net transfers to the rest of the world." [15]

"***The at-risk-of-poverty rate*** is the share of people with an equivalised disposable income (after social transfer) below the at-risk-of-poverty threshold, which is set at 60 % of the national median equivalised disposable income after social transfers. This indicator does not measure wealth or poverty, but low income in comparison to other residents in that country, which does not necessarily imply a low standard of living." [15]

"The at-risk-of-poverty rate before social transfers is calculated as the share of people having an equivalised disposable income before social transfers that is below the at-risk-of-poverty threshold calculated after social transfers. Pensions, such as old-age and survivors' (widows' and widowers') benefits, are counted as income (before social transfers) and not as social transfers. This indicator examines the hypothetical non-existence of social transfers. The persistent at-risk-of-poverty rate shows the percentage of the population living in households where the equivalised disposable income was below the at-risk-of-poverty threshold for the current year and at least two out of the preceding three years. Its calculation requires a longitudinal instrument, through which the individuals are followed over four years." [15]

The relationship between environmental protection and the well-being/poverty of the population is not explicitly addressed in the studies of various researchers. In relation to environmental spending, concerns concern the relationship between economic growth and the environment. Through this paper we wanted to evaluate how financial efforts to improve the environment influence (or not) the well-being/poverty of the population. From this perspective, to begin with, we wanted to review concerns of this type in the specialized literature.

In the article *"The impact of income inequality on public environmental expenditure with green consumers"* [2], the authors analyse the impact of income inequality on environmental policy in the presence of green consumers. Empirical analysis has highlighted a negative relationship between inequality and public environmental spending, which is weaker the higher the inequality. In addition, a negative correlation was found between environmental expenditure and green consumption, which shows the substitutable nature of the relationship between the two variables.

In the article *"Bridging the energy divide in a sustainable approach"* [13] the authors find that although the European Union is the international leader in terms of the energy transition, consumers are increasingly affected by overlapping crises affecting energy income and price levels, as the geopolitical context has become more volatile. Energy poverty is a complex problem, closely linked to social, political and economic elements, such as low incomes, exorbitant energy prices and inefficient housing. In addition to restricting comfort and well-being, energy poverty exacerbates social inequality, has serious health effects and hinders the development of a just and sustainable energy transition. Important steps have been taken in the EU to reduce energy poverty through targeted policies and initiatives, recognising the seriousness of this problem and to ensure access to energy and improve energy resilience.

In the article *"The energy divide: Integrating energy transitions, regional inequalities and poverty trends in the EU"* [1] the authors start from the fact that energy poverty can be understood as the inability of a household to provide a socially and materially necessary level of energy services in the home. Although this condition is widespread in Europe, its spatial and social distribution is extremely uneven. The existence of a geographical division of energy poverty in the European Union provides a starting point for conceptualising and exploring the relationship between energy transitions and existing patterns of regional economic inequality. The comprehensive analysis of spatial and temporal trends in energy poverty models on a national scale, as well as of gas and electricity prices, indicated that the classic distinction of economic development between the centre and the periphery is also valid in the case of energy poverty, as the incidence of this phenomenon is significantly higher in the EU Member States of southern and eastern Europe.

In the article *"Determinants of the expenditure side of environmental federalism – panel data research on countries in Europe"* [8] the author aimed to examine the influence of financial, socioeconomic and environmental degradation factors on the scope of expenditure within environmental federalism. Thus, the avoidance by local governments of both deficits and excessive indebtedness ends up promoting a greater scope of the expenditure side of environmental federalism. In addition, in European countries, the significance of expenditure on environmental protection visible in local budgets is increased for smaller economies, which are less ecologically degraded.

In the article *"Efficiency of environmental protection expenditure of the general governments in European Union Member States in the context of sustainable development in waste management"* [10] the authors show that the pursuit of sustainable development justifies spending in the field of environmental protection, as the active fiscal policy of the state is an essential determinant for achieving the Sustainable Development Goals. The distribution of public funds should depend on the efficiency of their use. In conclusion, it was observed that the positive relationships between general environmental expenditure and the achievement of sustainable objectives can be confirmed, even if, unfortunately, there is a problem related to the consistency of the data of the different indicators measuring sustainable objectives.

In the article *"The ecological poverty trap: Addressing the role of structural change, economic growth, trade, capital formation and democracy"* [6] the author, starting from the observation that despite long-standing empirical work and policy recommendations on climate change, the world has continued to face an ecological deficit since the early 1970s, investigates the direct and indirect effects of macroeconomic indicators on environmental poverty. The study aimed to measure environmental poverty by calculating the difference between the ecological footprint and biocapacity, and the empirical results document that a U-shaped relationship is observed between GDP per capita and ecological poverty. The author points out the factors that reduce environmental poverty (domestic investment, trade openness, the added value of agriculture, the added value of services and democracy), as well as those that affect environmental poverty (Value added in manufacturing, services and agriculture are appropriate transmission mechanisms through which FDI is achieved, GDP per capita, domestic investment, trade openness and democracy).

2. Study of the correlation between "National expenditure on environmental protection" and "At-risk-of-poverty rate" in the EU, Romania and Bulgaria, 2015-2022

In order to avoid the problems caused by the different size of the population (at the level of different countries) we considered it necessary to use the percentage indicators, both for the "National Expenditure on Environmental Protection" (percentage of the Gross Domestic Product) and for the "At-risk-of-poverty rate".

In Figure 1. the evolution of the "National Expenditure on Environmental Protection" (as Percentage of Gross Domestic Product) in the EU, in the period 2015-2024 is graphically represented (the data are taken from Annex 1). As we can see, the indicator shows a small variation close to 2%, respectively, in 2015-2017 it was 2%, then, after slight increases in the period 2017-2022, the level of 2% returned in 2023 and 2024.

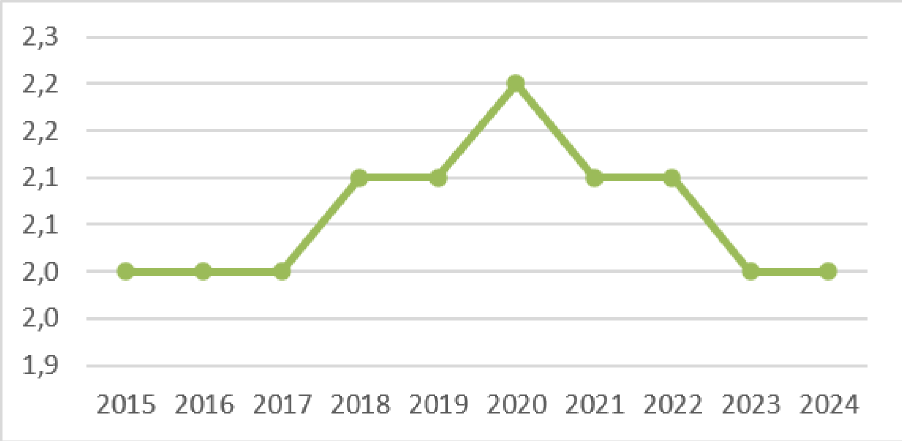

Figure 1. Evolution of "National Environmental Protection Expenditure" (percentage of gross domestic product) in the EU, 2015-2024

The evolution of the "At-risk-of-poverty rate" (%) in the EU, between 2015 and 2024, is shown in Figure 2. (data are taken from Annex 2). Even if there are alternate increases and decreases, the trend is downward throughout the analysed period. The variation of the indicator ranged from 17.5% (the maximum level in 2016) to 16.2% (the minimum level reached in 2023 and 2024).

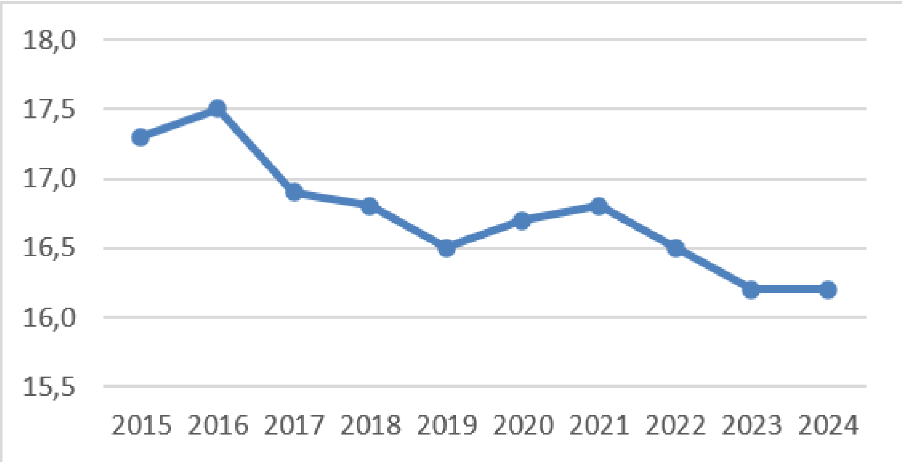

Figure 2. Evolution of the "At-of-Poverty Rate" (percentage) in the EU, 2015-2024

For the study of the link between "National expenditure on environmental protection" and "At-risk-of-poverty rate" we used a linear unifactorial regression model, the form of which is:

$y_i = \alpha + \beta \cdot x_i + \varepsilon_i$, $i = 1, 2, ...$ (1)

and the adjustment equation

$y_i = a + b \cdot x_i + e_i$, $i = 1, 2, ...$ (2)

where: y represents the dependent variable – "At-risk-of-poverty rate"; x is the independent variable – "National expenditure on environmental protection"; α it is the free term (it has no economic significance); β it is called the regression coefficient; ε it is called the residual variable.

The graphical approximation of the link model between the two variables is made using the scatter plot in Figure 3. The arrangement of the trend line allows us to observe that the link between the two variables is very weak.

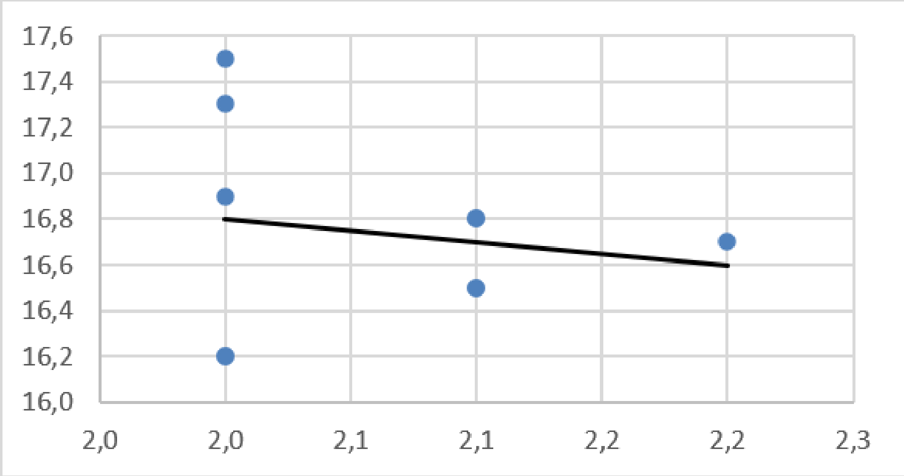

Figure 3. Scatter plot of the variables "National expenditure on environmental protection" and "At-risk-of-poverty rate" in the EU, 2015-2024

For *the estimation of the model parameters* we will apply the method of least squares, by means of the system of equations:

$$\begin{cases} na + b\sum x_i = \sum y_i \\ a\sum x_i + b\sum x_i^2 = \sum x_i y_i \end{cases} \quad (3)$$

Following the solution of the system (the calculations necessary to estimate the parameters are in Annex 3), the adjustment equation becomes:

$y_i = 18.80 - 1.00 \cdot x_i$

For the estimation of the parameters by confidence intervals we will use the calculations and results in Annex 4. *The confidence interval for the dimension* α is obtained with the relationship:

$$a - t_{\alpha/2,n-k} \cdot s_a \le \alpha \le a + t_{\alpha/2,n-k} \cdot s_a \quad (4)$$

where: n is the number of terms ($n=10$); k is the number of parameters of the model ($k=2$).

$t_{\alpha/2,n-k} = t_{0.025,8} = 2,3060$

$$s_a = s \cdot \sqrt{\frac{1}{n} + \frac{\bar{x}^2}{\sum(x_i - \bar{x})^2}} \quad (5)$$

$$s = \sqrt{\frac{\sum(y_i - Y_i)^2}{n-2}} \quad (6)$$

$$s = \sqrt{\frac{1.58}{10-2}} = 0,44$$

$$s_a = 0,44 \cdot \sqrt{\frac{1}{10} + \frac{2.1^2}{0.044}} = 4,3667$$

$18.80 - 2.3060 \cdot 4.3667 \le \alpha \le 18.80 + 2.3060 \cdot 4.3667$

$8.73 \le \alpha \le 28.87$

With the probability of 95%, we guarantee that α it falls between 8.73 and 28.87. Since the range does not contain 0, it follows that the parameter α is statistically significant.

The confidence interval for the dimension β is obtained with the relationship:

$$b - t_{\alpha/2,n-k} \cdot s_b \le \beta \le b + t_{\alpha/2,n-k} \cdot s_b \quad (7)$$

$$s_b = s \cdot \sqrt{\frac{1}{\sum(x_i - \bar{x})^2}} \quad (8)$$

$$s_b = 0.44 \cdot \sqrt{\frac{1}{0.044}} = 2,1186$$

$-1.00 - 2.3060 \cdot 2.1186 \le \beta \le -1.00 + 2.3060 \cdot 2.1186$

$-5.89 \le \beta \le 3.89$

With a 95% probability, we guarantee that β it falls between -5.89 and 3.89. Since the range contains 0, it follows that the parameter β is statistically insignificant.

The linear correlation coefficient will be (the calculations are in Annex 4):

$$r_{xy} = \frac{\sum(x_i-\bar{x})(y_i-\bar{y})}{\sqrt{\sum(x_i-\bar{x})^2\sum(y_i-\bar{y})^2}} \quad (9)$$

$$r_{xy} = \frac{-0.0440}{\sqrt{0.0440\cdot 1.6240}} = -0.1646$$

The result shows us an inverse and very low intensity relationship between the two variables.

The statistical assumptions for testing the significance of the linear correlation coefficient are:

H0: $\rho = 0$ (not statistically significant)

H1: $\rho \neq 0$ (is statistically significant)

The t-test will be:

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}} \quad (10)$$

$$t = \frac{-0.1646\sqrt{10-2}}{\sqrt{1-(-0.1646)^2}} = -0.4785$$

Because $|t|$ *(0.4785)* $<$ $t_{0.025;8}$ *(2.3060)* the H0 hypothesis, according to which the linear correlation coefficient is statistically insignificant, is accepted.

In order *to test the validity of the model, the following* statistical assumptions are issued:

H0: the independent variable does not have a significant influence on the dependent variable, and the Coefficient of Determination (R^2) is not statistically significant.

H1: the independent variable has a significant influence on the dependent variable, and the Coefficient of Determination (R^2) is statistically significant.

Test F is (the necessary calculations can be found in Annex 4):

$$F = \frac{\frac{\sum(Y_i-\bar{y})^2}{k-1}}{\frac{\sum(y_i-Y_i)^2}{n-k}} \quad (11)$$

$$F = \frac{\frac{0.044}{2-1}}{\frac{1.580}{10-2}} = 0.2228$$

The coefficient of determination (R^2) will be:

$$R^2 = \frac{\sum(Y_i-\bar{y})^2}{\sum(y_i-\bar{y})^2} \quad (12)$$

$$R^2 = \frac{0.044}{1.624} = 0.0271$$

The value obtained for R^2 leads us to the conclusion that the adjustment model is very weak.

As $F < F_{\alpha,k-1,n-k}$, i.e. F *(0.2228)* $<$ $F_{0.05;1;8}$ *(5.3177)* accepts the H0 hypothesis, according to which R2 is statistically insignificant.

Next, we will perform *the testing of the parameters* of the regression model. For *testing the parameter,* α the following hypotheses are issued:

H0: $\alpha = 0$ (not statistically significant)

H1: $\alpha \neq 0$ (is statistically significant)

The t-test will be:

$$t = \frac{a-0}{s_a} \quad (13)$$

$$t = \frac{18.80}{4.3667} = 4.3053$$

Whereas $|t| > t_{0.025;8}$ (*4.3053 > 2.3060*) the H1 hypothesis, according to which the parameter α is statistically significant, is accepted.

For *testing the parameter,* β the following hypotheses are issued:

H0: $\beta = 0$ (not statistically significant)

H1: $\beta \neq 0$ (is statistically significant)

The t-test will be:

$$t = \frac{b-0}{s_b} \quad (14)$$

$$t = \frac{-1.00}{2.1186} = -0.472$$

How $|t|$ *(0.472)* < $t_{0.025;8}$ *(2.3060)* follows that the parameter β is insignificantly different from 0.

To assess the link between "National Expenditure on Environmental Protection" and the "At-risk-of-Poverty Rate" at the level of EU states, we selected Romania and its neighbours Bulgaria and Hungary. Unfortunately, in the Eurostat databases for Hungary "Expenditure on environmental protection" is only found for 5 years (2018-2022), which is why we have removed it from the study. The results obtained for Romania and Bulgaria are as follows (Table 1):

Table 1. Results specific to the linear regression model for Bulgaria and Romania

Indicators	**Bulgaria**	**Romania**
Linear regression model	y_i = 23,80 - 0,52 $\cdot x_i$	y_i = 31,66 - 3,38 $\cdot x_i$
Confidence interval for α	20,35 ≤ α ≤ 27,25	24,74 ≤ α ≤ 38,58
Confidence interval for β	-2,15 ≤ β ≤ 1,10	-6,26 ≤ β ≤ -0,51
Linear correlation coefficient r_{xy}	-0,3056	-0,7614
t_r	-0,8255	-4,4378
T	2,4469	2,4469
Fstat Statistics	0,62	8,28
Ftab	5,99	5,99
Coefficient of determination R2	0,0934	0,5797
t_a	16,89	11,20
t_b	-0,79	-2,88

For the evaluation of the ***Bulgarian model,*** the calculations necessary to estimate the parameters are in Annex 5, the adjustment equation being:

y_i = 23.80 – 0.52 $\cdot x_i$

The estimation of the parameters by confidence intervals (the calculations can be found in Annex 6), leads us to the observation that, with a probability of 95%, α they fall between the values of 20.35 and 27.25, and β between the values of -2.15 and 1.10. It follows that α it is statistically significant (because the range does not contain 0), on the other hand, β it is statistically insignificant (because the range contains 0). So, the model is not statistically valid.

The linear correlation coefficient is -0.3056 (the calculations are in Annex 6) and reveals a rather small inverse link, and the test shows us that it is statistically insignificant: $|t|$ *(0.8255)* < $t_{0.025;6}$ *(2.4469)*.

The coefficient of determination (R^2) shows a very low level (0.0934).

As *Fstat* < $F_{\alpha,k-1,n-k}$, i.e. *F (0.62)* < $F_{0.05;1;6}$ *(5.99)* means that the model is statistically invalid.

For the evaluation of the model in ***Romania,*** the calculations necessary to estimate the parameters are in Annex 7, the adjustment equation being:

y_i = 31.66 – 3.38 $\cdot x_i$

The estimation of the parameters by confidence intervals (the calculations are in Annex 8), lead us to the observation that, with a probability of 95%, α they fall between the values of 24.74 and 38.58, and β between the values -6.26 and -0.51. Since the ranges do not contain the 0, it follows that both parameters are statistically significant.

The linear correlation coefficient is -0.7614 (the calculations are in Annex 8) and reveals an inverse link of average intensity, and the test shows us that it is statistically significant: $|t|$ *(4.4378)* > $t_{0.025;6}$ *(2.4469)*.

The coefficient of determination (R^2) has a rather low level (0.5797).

As *Fstat* > $F_{\alpha,k-1,n-k}$, adică *F (8.28)* > $F_{0.05;1;6}$ *(5.99)* means that the model is statistically valid.

3. Conclusions

The evolution of "National expenditure on environmental protection" shows a small variation close to 2%. The evolution of the "At-risk-of-poverty rate" shows a downward trend, from the maximum value of 17.5% (in 2016) to the minimum value of 16.2% (the level reached in 2023 and 2024).

The assessment of the link between "National expenditure on environmental protection" and "At-risk-of-poverty rate" at EU27 level was carried out using a linear unifactorial regression model:

$y_i = 18{,}80 - 1{,}00 \cdot x_i$

The estimation of the confidence intervals of the parameters indicates that they α fall between 8.73 and 28.87, and β between -5.89 and 3.89. It follows that the parameter α is statistically significant and the parameter β is insignificant. Therefore, the model is statistically insignificant for the two variables.

The linear correlation coefficient by the low value obtained (-0.1646) shows a very weak inverse link between "Environmental spending" and "At-risk-of-poverty rate". At the same time, testing the significance of the linear correlation coefficient shows us that this indicator is statistically insignificant.

Testing the validity of the model leads us to the conclusion that the coefficient of determination (R^2) is statistically insignificant.

The simple linear regression model obtained for Romania is statistically valid, on the other hand, in the case of Bulgaria, the model obtained is invalid. We also noted that they highlight a weak intensity inverse link for Bulgaria and a medium intensity inverse link for Romania.

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ANNEXES

Annex 1. Evolution of 'National Environmental Spending' in the EU27, Bulgaria, Hungary and Romania 2015-2024

-Percentage of gross domestic product (GDP)-

Year	EU27	Bulgaria	Hungary	Romania
2015	2,0	3,0	:	2,3
2016	2,0	2,2	:	1,8
2017	2,0	2,0	:	2,1
2018	2,1	1,8	1,5	2,5
2019	2,1	1,9	1,6	2,5
2020	2,2	2,0	1,6	2,5
2021	2,1	2,0	1,4	2,7
2022	2,1	1,8	1,3	2,7
2023	2,0	:	:	:
2024	2,0	:	:	:

Source: https://ec.europa.eu/eurostat/databrowser/view/env_ac_epneis1/default/table?lang=en&category=env.env_epe.env_ac_epea

Annex 2. Evolution of 'At-risk-of-poverty rate' in the EU27, Bulgaria, Hungary and Romania 2015-2025

-Percentage-

Year	EU27	Bulgaria	Hungary	Romania
2015	17,3	22,0	14,9	25,4
2016	17,5	22,9	14,5	25,3
2017	16,9	23,4	13,4	23,6
2018	16,8	22,0	12,8	23,5
2019	16,5	22,6	14,0	23,8
2020	16,7	23,8	13,9	23,4
2021	16,8	22,1	13,2	22,5
2022	16,5	22,9	13,5	21,2
2023	16,2	20,6	13,8	21,1
2024	16,2	21,7	14,3	19,0
2025	16,0	21,2	14,0	18,4

Source: https://ec.europa.eu/eurostat/databrowser/view/ILC_LI02/default/table

Annex 3. Calculations needed to estimate the parameters of the EU regression model

Year	*xi - Cnpm*	*yi - Arop*	*xi^2*	*yi^2*	*xi*yi*	*Yi*
2015	2,0	17,3	4,0	299,29	34,60	16,800
2016	2,0	17,5	4,0	306,25	35,00	16,800
2017	2,0	16,9	4,0	285,61	33,80	16,800
2018	2,1	16,8	4,4	282,24	35,28	16,700
2019	2,1	16,5	4,4	272,25	34,65	16,700
2020	2,2	16,7	4,8	278,89	36,74	16,600
2021	2,1	16,8	4,4	282,24	35,28	16,700
2022	2,1	16,5	4,4	272,25	34,65	16,700
2023	2,0	16,2	4,0	262,44	32,40	16,800
2024	2,0	16,2	4,0	262,44	32,40	16,800
Total	**20,6**	**167,4**	**42,5**	**2803,90**	**344,80**	**167,4**

Annex 4. Calculations needed to determine total variance, explained variance and residual variance for the EU

Year	*(xi-xm)²*	*(yi-Yi)²*	*(xi-xm)(yi-ym)*	*(yi-ym)²*	*(Yi-ym)²*
2015	0,0036	0,2500	-0,0336	0,3136	0,0036
2016	0,0036	0,4900	-0,0456	0,5776	0,0036
2017	0,0036	0,0100	-0,0096	0,0256	0,0036
2018	0,0016	0,0100	0,0024	0,0036	0,0016
2019	0,0016	0,0400	-0,0096	0,0576	0,0016
2020	0,0196	0,0100	-0,0056	0,0016	0,0196
2021	0,0016	0,0100	0,0024	0,0036	0,0016
2022	0,0016	0,0400	-0,0096	0,0576	0,0016
2023	0,0036	0,3600	0,0324	0,2916	0,0036
2024	0,0036	0,3600	0,0324	0,2916	0,0036
Total	**0,0440**	**1,5800**	**-0,0440**	**1,6240**	**0,0440**

Annex 5. Calculations necessary to estimate the parameters of the regression model for Bulgaria

Year	*xi - Cnpm*	*yi - Arop*	*xi^2*	*yi^2*	*xi*yi*	*Yi*
2015	3,0	22,0	9,0	484,0	66,0	22,2
2016	2,2	22,9	4,8	524,4	50,4	22,7
2017	2,0	23,4	4,0	547,6	46,8	22,8
2018	1,8	22,0	3,2	484,0	39,6	22,9
2019	1,9	22,6	3,6	510,8	42,9	22,8
2020	2,0	23,8	4,0	566,4	47,6	22,8
2021	2,0	22,1	4,0	488,4	44,2	22,8
2022	1,8	22,9	3,2	524,4	41,2	22,9
Total	**16,7**	**181,7**	**35,9**	**4130,0**	**378,7**	**181,7**

Annex 6. Calculations necessary to determine the total variance, explained variance and residual variance for Bulgaria

Year	*(xi-xm)²*	*(yi-Yi)²*	*(xi-xm)(yi-ym)*	*(yi-ym)²*	*(Yi-ym)²*
2015	0,8327	0,0554	-0,6502	0,5077	0,2276
2016	0,0127	0,0607	0,0211	0,0352	0,0035
2017	0,0077	0,4118	-0,0602	0,4727	0,0021
2018	0,0827	0,7444	0,2048	0,5077	0,0226
2019	0,0352	0,0443	0,0211	0,0127	0,0096
2020	0,0077	1,0853	-0,0952	1,1827	0,0021
2021	0,0077	0,4333	0,0536	0,3752	0,0021
2022	0,0827	0,0014	-0,0539	0,0352	0,0226
Total	**1,0688**	**2,8366**	**-0,5588**	**3,1288**	**0,2921**

Annex 7. Calculations necessary to estimate the parameters of the regression model for Romania

Year	*xi - Cnpm*	*yi - Arop*	*xi^2*	*yi^2*	*xi*yi*	*Yi*
2015	2,3	25,4	5,3	645,2	58,4	23,9
2016	1,8	25,3	3,2	640,1	45,5	25,6
2017	2,1	23,6	4,4	557,0	49,6	24,6
2018	2,5	23,5	6,3	552,3	58,8	23,2
2019	2,5	23,8	6,3	566,4	59,5	23,2
2020	2,5	23,4	6,3	547,6	58,5	23,2
2021	2,7	22,5	7,3	506,3	60,8	22,5
2022	2,7	21,2	7,3	449,4	57,2	22,5
Total	**19,1**	**188,7**	**46,3**	**4464,2**	**448,3**	**188,7**

Annex 8. Calculations Needed to Determine Total Variance, Explained Variance, and Residual Variance for Romania

Year	*(xi-xm)²*	*(yi-Yi)²*	*(xi-xm)(yi-ym)*	*(yi-ym)²*	*(Yi-ym)²*
2015	0,0077	2,3002	-0,1586	3,2852	0,0875
2016	0,3452	0,0751	-1,0061	2,9327	3,9463
2017	0,0827	0,9209	-0,0036	0,0002	0,9450

2018	0,0127	0,0858	-0,0098	0,0077	0,1447
2019	0,0127	0,3515	0,0239	0,0452	0,1447
2020	0,0127	0,0372	-0,0211	0,0352	0,1447
2021	0,0977	0,0010	-0,3398	1,1827	1,1165
2022	0,0977	1,7711	-0,7461	5,7002	1,1165
Total	**0,6688**	**5,5428**	**-2,2613**	**13,1888**	**7,6460**