

Assessing EU environmental policies effectiveness on the economic development of Bulgaria

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Abstract. The study explores the effect of the European Structural and Investment Funds, intended to implement EU Environmental Policies on the development of the Bulgarian economy. Efforts are focused on measuring the strength and direction of the stochastic relationships between the absorbed funds provided by: the European Agricultural Fund for Rural Development (EAFRD), the European Maritime and Fisheries Fund (EMFF), the European Regional Development Fund (ERDF) and the Cohesion Fund (CF) on the Bulgarian gross domestic product for the period 2014 - 2022. The methodology used to study the observed stochastic processes includes various types of linear and non-linear regressions, correlation analysis, ANOVA, multicollinearity, and normality of residuals.

1. Introduction

The European Green Deal program aims to make a transition to a carbon-neutral (clean) economy, that is, to decarbonize the European economy. Huge financial resources were allocated to the member countries of the community in order to implement these EU environmental policies. But in recent years, the EU's environmental policies have faced increasingly growing resistance. Their effectiveness and actual results are controversial, and subject to discussion [1-2]. In a significant number of European countries, the cost of a green economy is considered too high and the social cost hardly acceptable for society [3-4]. The situation is similar in Bulgaria. The short-sighted and inadequate policies of the 7 successive Bulgarian governments for the last 3 years threaten to cause high levels of unemployment in the energy sector and disrupt the country's energy balance.

The problems of the influence of European funds and programs are the subject of research by a significant number of researchers and experts [5-7]. But the publications regarding the research of the effectiveness of funds, related to the implementation of EU Environmental Policies on the development of national economies, are significantly limited.

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Spanish explorers developed the Environmental Performance Assessment Composite Index, in the framework of the 2050 Europe vision [8]. They find that Sweden, Austria, Denmark, Italy and Germany have better scores in environmental performance assessment, and Slovakia, Romania, Czech Republic, Poland and Lithuania have the lowest scores in the composite index.

A team of Chinese researchers use several data envelopment analysis (DEA) approaches to evaluate the environmental efficiency of EU countries, considering the allocation of fixed environmental costs and three different decision objectives for each member state [9]. Their empirical results for the 28 EU member states from 2013 to 2019 show that the efficiency scores of each member remained broadly stable but member states that joined the EU earlier have higher efficiency values under economic priority.

The article aims to examine the direction and specific influence of these European structural and investment funds related to the implementation of EU Environmental Policies on the development of the Bulgarian economy for the last 9 years.

2. Materials and methods

The EU Environmental Policies effectiveness evaluation on the economic development of Bulgaria is carried out on the basis of specific data about the sums absorbed by the country under investment and structural funds by year. For this purpose, public information from the summary reports of the European Structural and Investment Funds, annual implementation reports, annexes to the report by the European Commission, Eurostat and the National Statistical Institute of Bulgaria was used.

Specifically, efforts are focused on measuring the strength and direction of the stochastic relationship between the sums absorbed by Bulgaria from the European Structural and Investment Funds (related to the implementation of EU Environmental Policies) and the dynamics of the gross domestic product for the period 2014-2022.

The methodology used to study the observed stochastic relations includes various types of linear and non-linear regressions, correlation analysis, ANOVA, multicollinearity analysis, normality of residuals, etc.

Table 1 presents the planned and utilized funds under the cohesion fund of Bulgaria for the program period 2014-2022. It can be seen that from 2015 to 2022, stable funding in the amount of 2,278,307.14 thousand euros per year is foreseen.

Table 1. Planned and absorbed cash flows under the Cohesion Fund for the period 2014-2022.

Years	Planned funds in thousand €	Disbursed funds in thousand €
2014	€1,144,687.26	€0.00
2015	€2,278,307.14	€42,832.17
2016	€2,278,307.14	€75,323.39
2017	€2,278,307.14	€108,984.33
2018	€2,278,307.14	€191,934.34
2019	€2,278,307.14	€233,280.84
2020	€2,206,897.42	€299,888.15
2021	€2,206,897.42	€379,410.87
2022	€2,206,897.42	€432,412.01

Figure 1 provides a visual representation of the planned and used cash flows in thousands of euros under the Cohesion Fund for the period 2014-2022. The data shows that there is a significant gap between planned and used amounts, which narrows slightly towards the end of the target period.

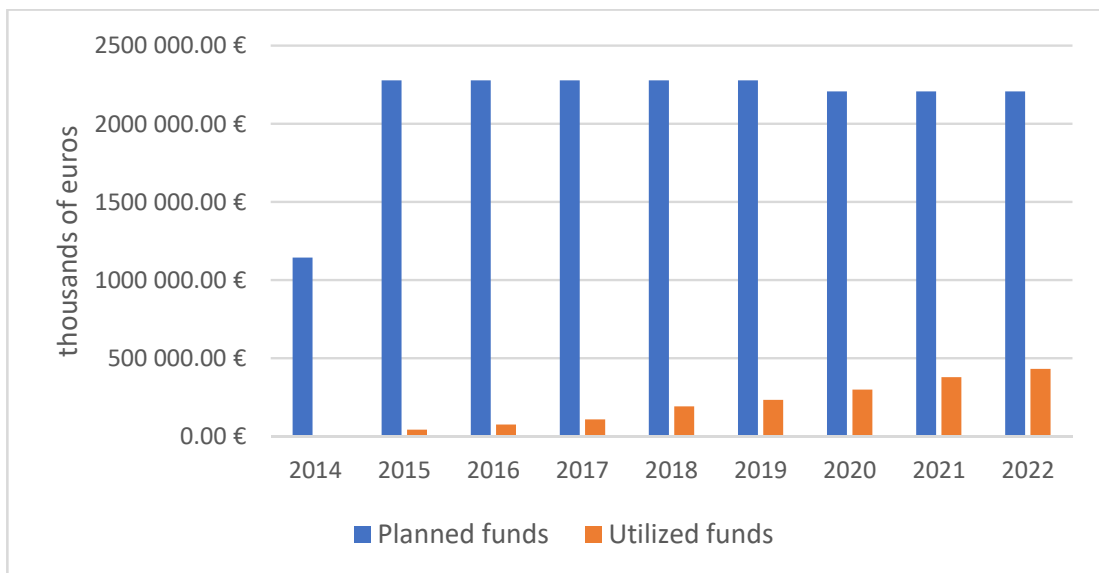


Fig. 1. Planned and utilized Cohesion Fund (CF) funds in Bulgaria by year , thousands €.

Figure 1 visualizes this gap. It can be seen that, over the years, Bulgaria has been slowly increasing the share of the sums absorbed, which speaks of the improved administrative capacity of central government and local administration.

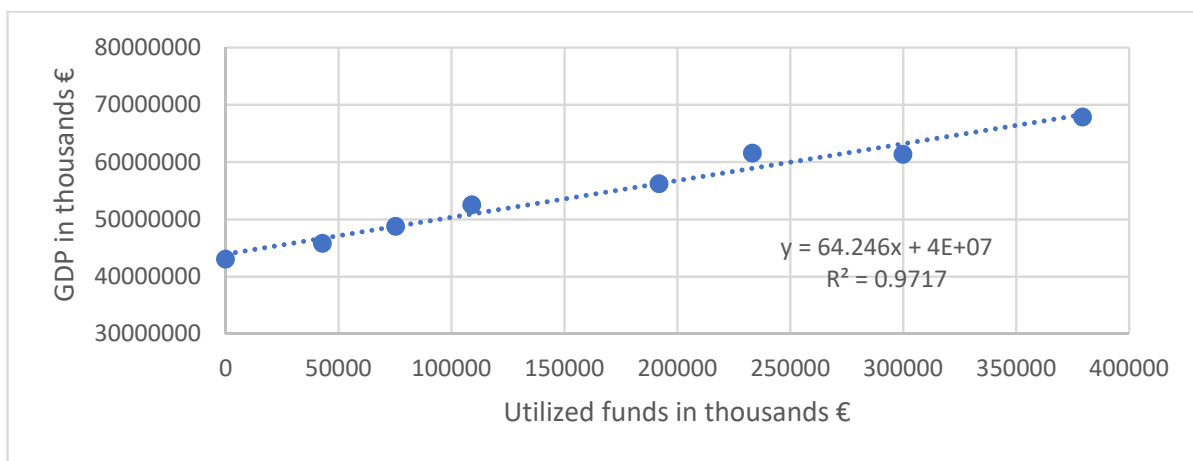


Fig. 2.Correlogram the utilized funds against GDP.

Figure 2 illustrates by a correlogram the almost linear relationship between the utilized funds under the cohesion fund of Bulgaria and the dynamics in GDP for the program period 2014-2022.

Table 2.Regression Statistics.

Statistical measures	Value
Correlation coefficient R	0.988199706
Coefficient of determination	0.976538659
Adjusted R Square	0.973187039
Standard error	1559282.9
Observations	9

It can be seen in Table 2, that a strong correlation relationship is observed ($R=0.9881$). The value of the coefficient of determination of $R^2 = 0.97$ gives reason to conclude that the chosen linear model is suitable as a stochastic model for the particular stochastic relationship.

Table 3. Coefficient, t Stat and P-value.

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	44217426.0	879237,92	50.2906262	0.00000	42138358.71	46296493
CF	61.7574271	3.6180275	17.0693634	0.00000	53.20215145	70.3127

Table 3 shows the estimated values of the regression coefficients, their standard errors, the empirical t values, their significance levels, and the 95% probability interval estimates. It can be seen that both the calculated value of the regression coefficient and the intercept are statistically significant.

Table 4. Analysis of variance (ANOVA).

	df	SS	MS	F	Significance F
Regression	1	708409674938769	708409674938769	291.3631687	0.0000006
Residual	7	17019542127812	2431363161116		
Total	8	725429217066581			

Table 4 gives an idea for the calculated measures of the analysis of variance: degrees of freedom, explained and residual variance, estimates of total variance, empirical value of the F test and its level of significance. The calculated low significance level value indicates a high degree of statistical significance of the selected linear model.

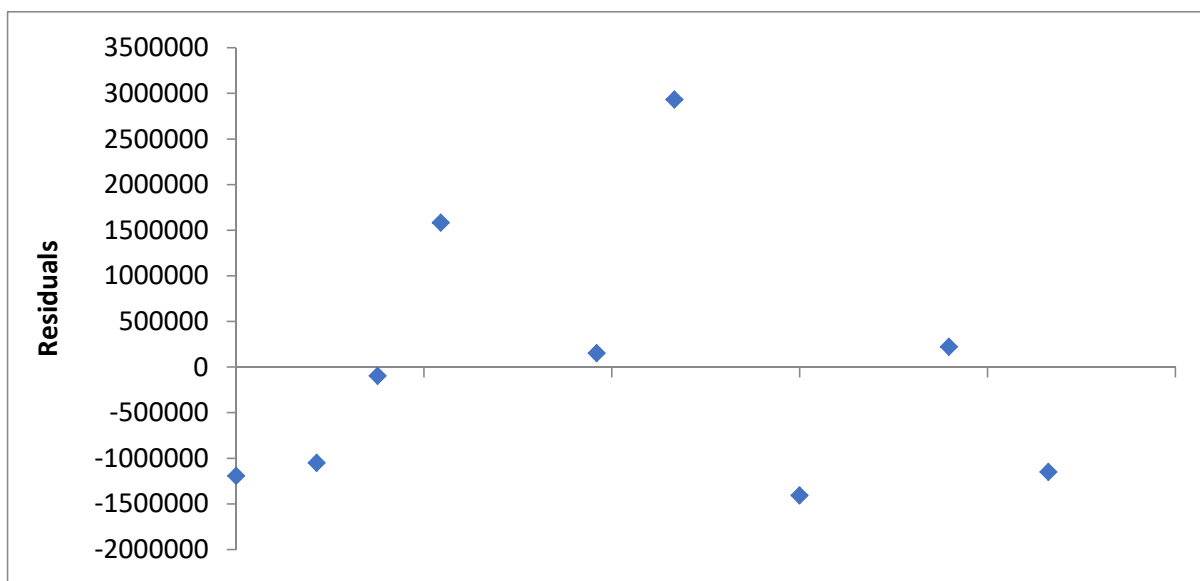


Fig. 3. Residual plot independent variable CF.

Figure 3 illustrates the distribution of the residuals by independent variable used CF funds. The graph shows that their distribution is random, which confirms the adequacy of the model.

Table 5 presents the planned and utilized funds under the European Agricultural Fund for Rural Development (EAFRD) of Bulgaria for the program period 2014-2022. It can be seen that from 2015 to 2020 a stable funding in the amount of 2,366,716 .97 thousand euros per year is observed, and then for the last two years fund is raised to 3,129,044.78 thousand euros per year. It is evident from the data that there is a significant gap between planned and utilized amounts, which decreases to a small extent towards the end of the targeted period.

Table 5. Planned and absorbed EAFRD cash flows for the period 2014-2022.

Year	Planned funds, in thousand €	Disbursed funds in thousand €
2015	€2,366,716.97	€47,334.34
2016	€2,366,716.97	€200,061.55
2017	€2,366,716.97	€394,575.61
2018	€2,366,716.97	€600,258.93
2019	€2,366,716.97	€908,893.69
2020	€2,366,716.97	€1,211,920.79
2021	€3,129,044.78	€1,566,577.17
2022	€3,129,044.78	€1,762,925.66

Figure 4. visualizes this gap. It can be seen that, over the years, Bulgaria has been slowly increasing the share of the sums absorbed, which speaks of the improved administrative capacity of central government and local administration.

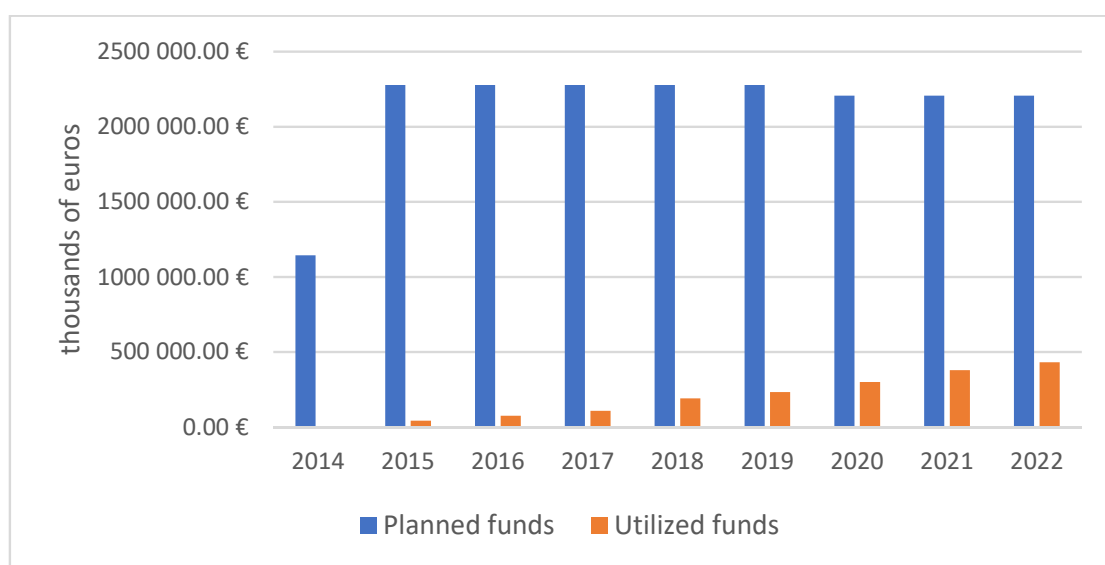


Fig. 4. Planned and utilized EAFRD funds in Bulgaria by year, thousands €.

Figure 5 illustrates a correlogram of the non-linear relationship between the funds used under the European Agricultural Fund for Rural Development (EAFRD) and the dynamics in the GDP of Bulgaria for the program period 2014-2022.

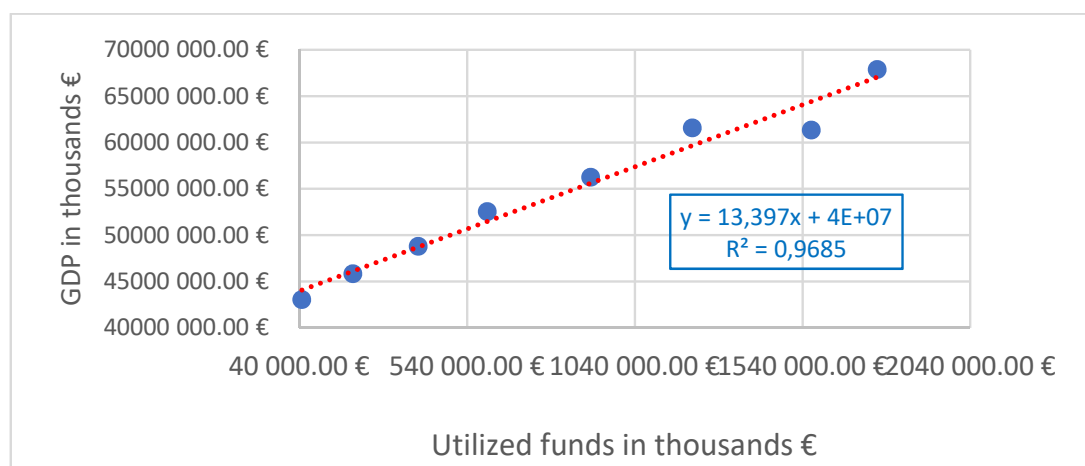


Fig. 5. Correlogram of EAFRD disbursements against GDP.

It can be seen from the data in Table 6 that a strong correlation relationship is observed (correlation coefficient $R=0.9841$). The value of the coefficient of determination $R^2 = 0.968$ gives us a reason to conclude that the chosen linear model is suitable for the study of the particular stochastic relationship.

Table 6. Regression Statistics.

Statistical measures	Value
Correlation coefficient R	0.984105279
Coefficient of determination	0.9684632
Adjusted R Square	0.963207067
Standard error	1656266.849
Observations	8

Table 7 shows the calculated indicators of ANOVA: degrees of freedom, explained and residual variance, estimates of total variance, empirical value of the F test and its level of significance. The calculated low F sign. value indicates a high degree of statistical significance of the selected linear model.

Table 7. Analysis of variance (ANOVA).

	df	SS	MS	F	Significance F
Regression	1	505449035808743	505449035808743	184.2539274	0.0000099
Residual	6	16459319250007	2743219875001		
Total	7	521908355058750			

Table 8 shows the estimated values of the regression coefficients, their standard errors, the empirical t values, their significance levels, and the 95% probability interval estimates. It can be seen that both the calculated value of the regression coefficient and the intercept are statistically significant.

Table 8. Coefficient, t Stat and P-value.

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	43433972.81	1012207,62	42,910	0.000000	40957190	45910755.63
EAFRD	13.39650022	0.986922337	13,574	0.000009	10.981588	15.81141218

Figure 6 illustrates the distribution of the residuals of the independent variable EAFRD. The graph shows that their distribution is asymptotic random, which confirms the adequacy of the model.

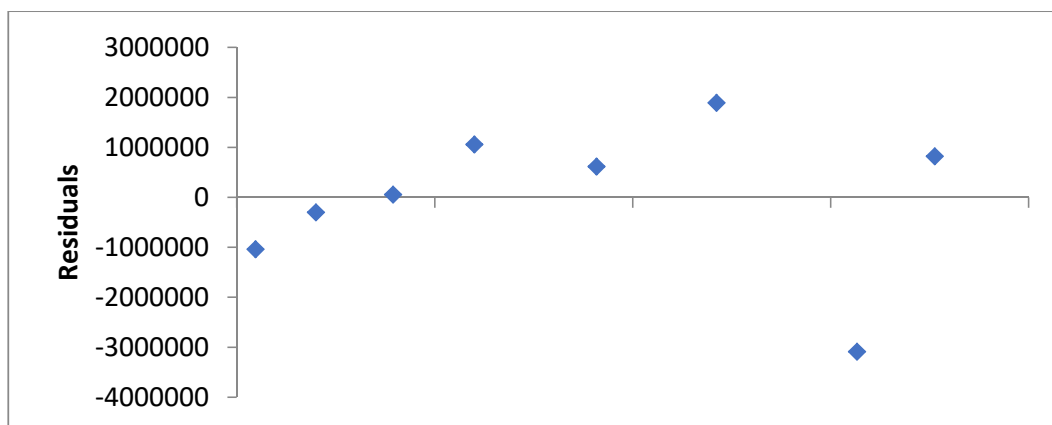


Fig. 6. Residual plot independent variable EAFRD.

Table 9 presents the planned and utilized funds under the European Maritime and Fisheries Fund for the program period 2015-2022. It can be seen that from 2015 to 2022, stable funding is foreseen in the amount of €88,066.62 thousand per year.

Table 9.Planned and absorbed EMFF cash flows for the period 2014-2022.

years	Planned funds in thousand €	Disbursed funds in thousand €
2015	€88,066.62	€1,655.65
2016	€88,066.62	€4,139.13
2017	€88,066.62	€4,656.52
2018	€88,066.62	€5,458.56
2019	€88,066.62	€13,078.70
2020	€88,066.62	€24,443.14
2021	€88,066.62	€35,190.46
2022	€88,066.62	€44,527.63

Figure 7 gives a visual idea about the planned and utilized cash flows in thousands of euros under the Cohesion Fund for the period 2014-2022. It is clear from the data that there is a significant gap between planned and utilized amounts, which decreases to a small extent towards the end of the considered period.

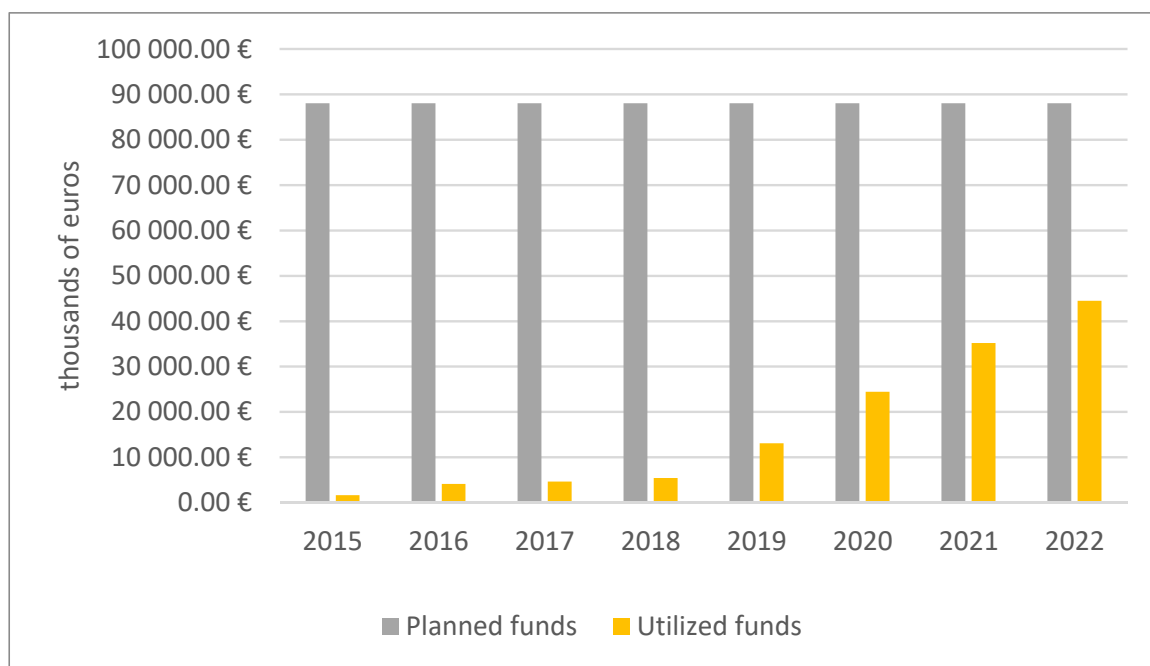


Fig. 7.Planned and utilized EMFF funds in Bulgaria by year in thousands of €

Figure 8 illustrates a correlogram of the logarithmic relationship between the funds used under the European Maritime and Fisheries Fund and the dynamics of Bulgaria's GDP for the program period 2014-2022.

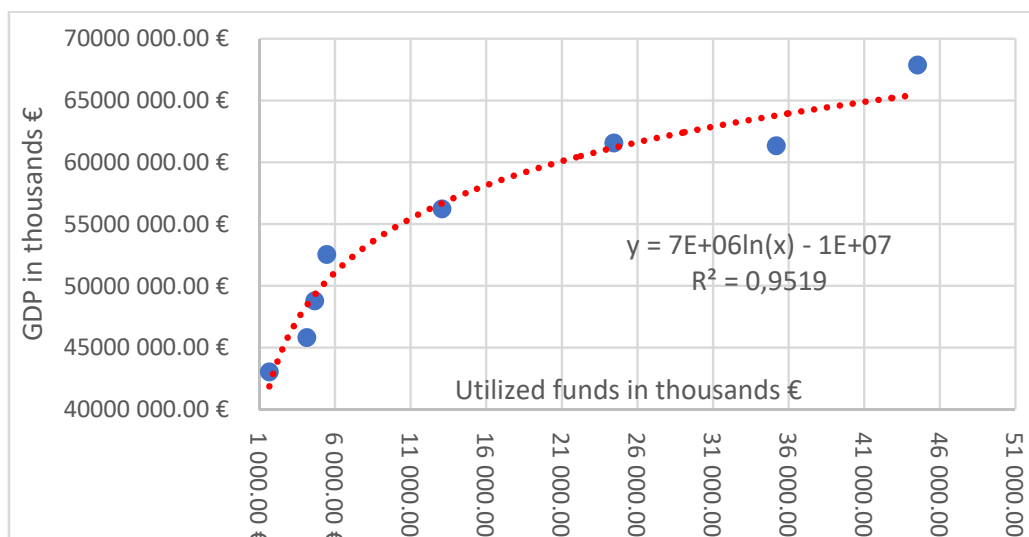


Fig. 8. Correlogram of EMFF disbursements against GDP.

It can be seen from the data in table 10 that a strong correlation relationship is observed ($R=0.975$). The value of the coefficient of determination of $R^2 = 0.95$ gives reason to conclude that the chosen logarithmic model is suitable for the study of the particular stochastic relationship.

Table 10. Regression statistics.

Statistical measure	Value
Correlation coefficient R	0.975653627
Coefficient of determination	0.9519
Adjusted R Square	0.858327788
Standard error	3250052,987
Observations	8

Table 11 shows the calculated indicators of the analysis of variance: degrees of freedom, explained and residual variance, estimates of total variance, empirical value of the F test and its level of significance. The calculated value of *Significance F* means a high degree of statistical significance of the selected logarithmic model.

Table 11. Analysis of variance (ANOVA).

	df	SS	MS	F	Significance F
Regression	1	458531288554409	458531288554409	43.40983076	0.000587093
Residual	6	63377066504340	10562844417390		
Total	7	521908355058750			

Table 12 shows the estimated values of the regression coefficients, their standard errors, the empirical t values, their significance levels, and the 95% probability interval estimates. It can be seen that both the calculated value of the regression coefficient and the intercept are statistically significant.

Table 12. Coefficient, t Stat and P-value.

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	46343405.4	1704824,75	27,18	0,000001	42171849.61	50514961.38
EMFF	498.545658	75.667762	6.58	0.000587	313.3933133	683.6980028

Figure 9 illustrates the distribution of the residuals by independent variable EMFF. The graph shows that their distribution is asymptotic random, which confirms the adequacy of the model.

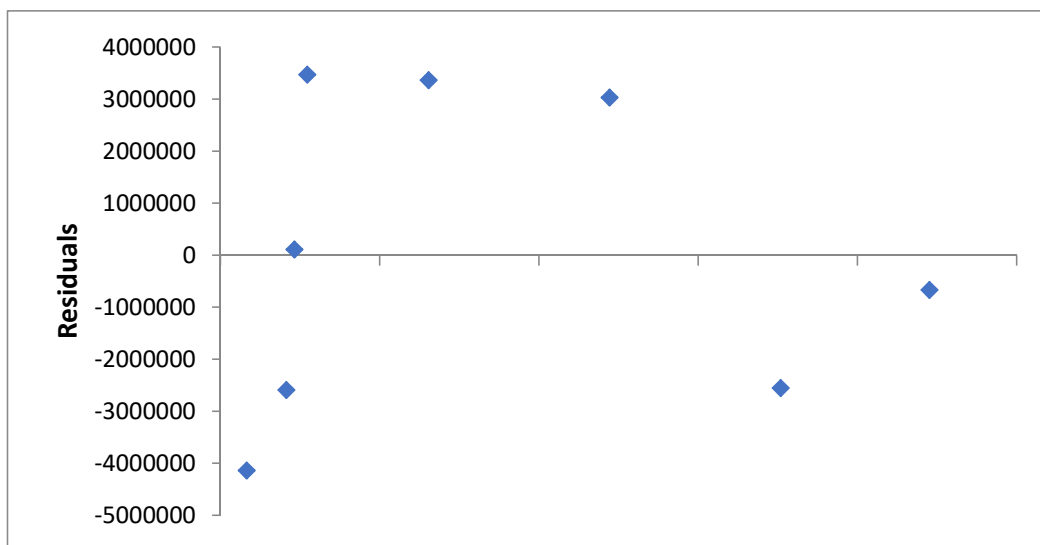


Fig. 9. Residual plot independent variable EMFF

Table 13 presents the planned and utilized funds under the European Regional Development Fund for the program period 2014-2022. It can be seen that from 2015 to 2022, stable funding is planned in the amount of 3,567,667.61 thousand euros per year.

Table 13. Planned and absorbed ERDF cash flows for the period 2014-2022.

years	Planned funds	Disbursed funds in thousand €
2014	€459,761.91	€0.00
2015	€3,567,667.61	€67,072.15
2016	€3,567,667.61	€381,447.60
2017	€3,567,667.61	€656,630.83
2018	€3,567,667.61	€987,687.78
2019	€3,567,667.61	€1,454,244.93
2020	€3,627,082.06	€1,856,759.06
2021	€3,813,837.81	€2,423,622.91
2022	€3,883,489.12	€2,899,198.86

Figure 10 provides a visual representation of the planned and utilized cash flows in thousands of euros under the European Regional Development Fund for the period 2014-2022. The data shows that there is a significant gap between planned and utilized amounts, which narrows to a large extent towards the end of the relevant period.

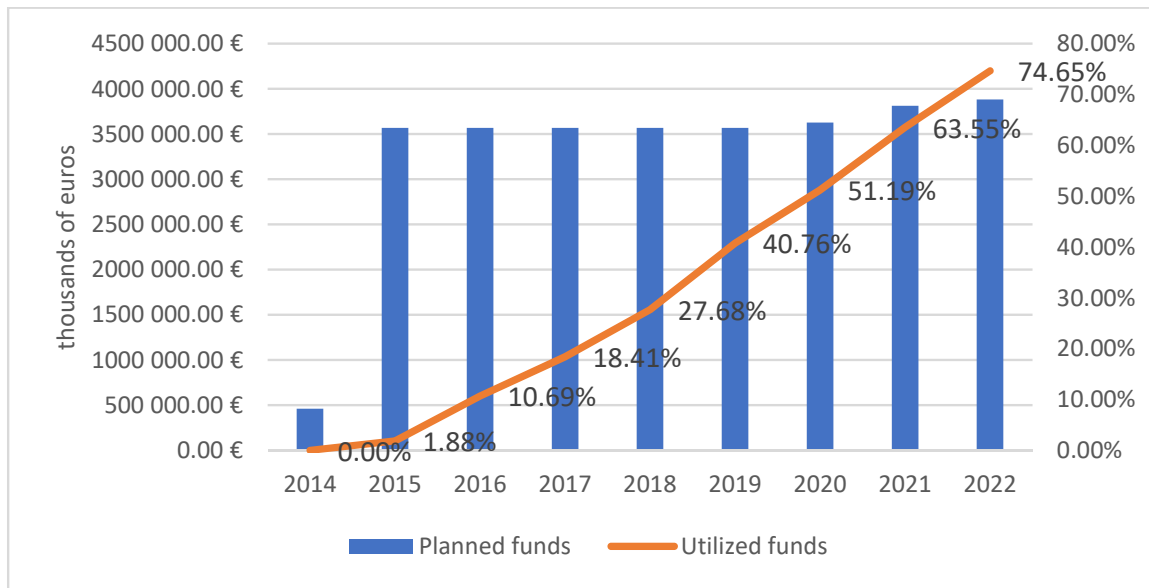


Fig. 10. Planned and utilized ERDF funds in Bulgaria by year, thousands of €.

Figure 11. illustrates a correlogram the non-linear relationship between the absorbed European Regional Development Funds and the dynamics in the GDP of Bulgaria for the program period 2014-2022.

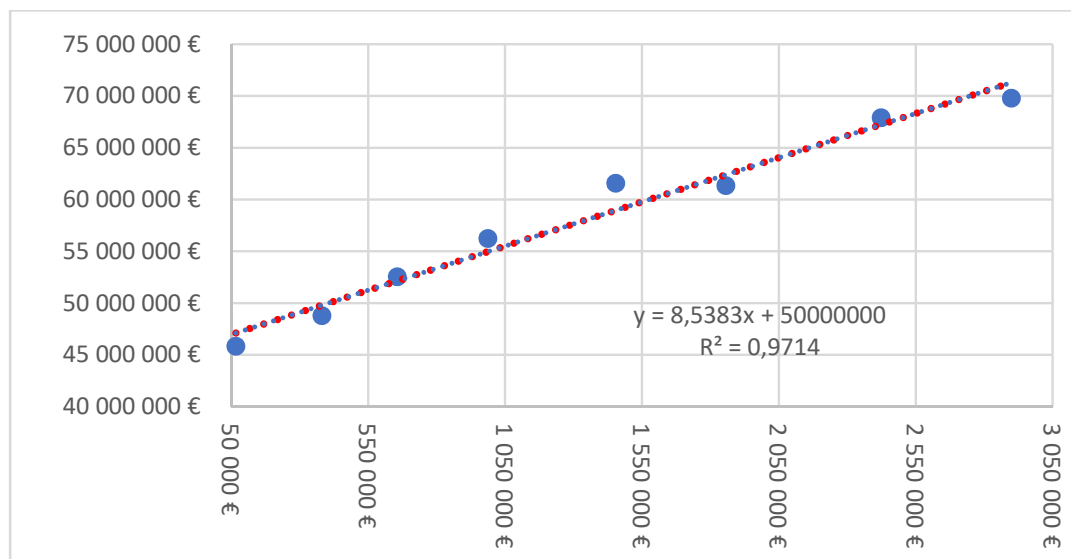


Fig. 11. Correlogram of ERDF disbursements against GDP.

It can be seen in Table 14, that a strong correlation relationship is observed ($R=0.983$). The value of the coefficient of determination of $R^2 = 0.966$ gives reason to conclude that the chosen linear model is suitable for the study of the particular stochastic relationship.

Table 14. Regression Statistics.

Statistical measure	Value
Correlation coefficient R	0.98332514
Coefficient of determination	0.966928331
Adjusted R Square	0.962203807
Standard error	1851298.958
Observations	9

Table 15 provides an insight into the estimated measures of the analysis of variance: degrees of freedom, residual variance explained, estimates of total variance, empirical value of the F test, and its significance level. The calculated small value of Significance F means a high degree of statistical significance of the selected linear model.

Table 15. Analysis of variance (ANOVA)

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	701438062252231	701438062252231	204.6615294	0.00000194
Residual	7	23991154814349	3427307830621		
Total	8	725429217066581			

Table 16 shows the estimated values of the regression coefficients, their standard errors, the empirical t values, significance levels and the 95% probability interval estimates. It can be seen that both the calculated value of the regression coefficient and the intercept are statistically significant.

Table 16. Coefficient, t Stat and P-value.

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Intercept	45567102.59	972632.31	46.84	0.00000	43267192.63	47867012.56
ERDF	9.023970031	0.6307823	14.30	0.000193	7.532406775	10.51553329

Figure 12 illustrates the distribution of the residuals for the independent variable ERDF. The graph shows that their distribution is asymptotic random, which confirms the adequacy of the model.

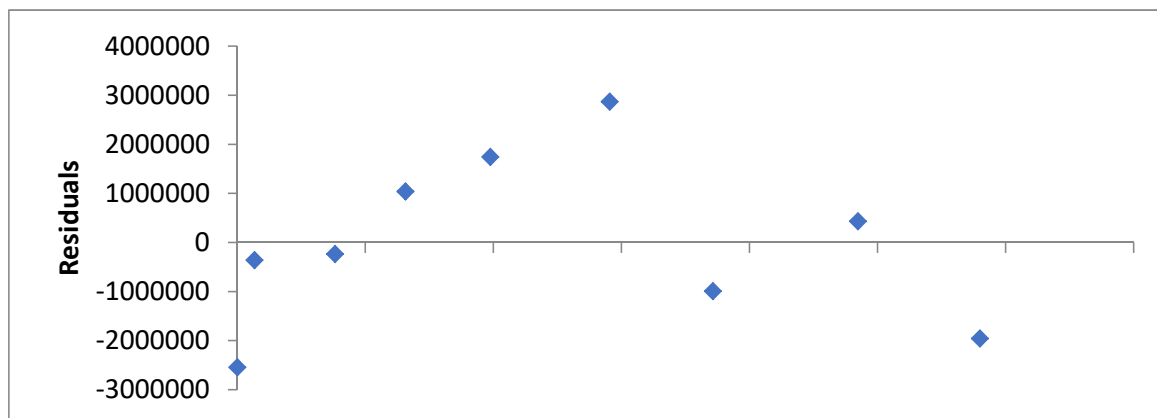


Fig. 12. Residual plot independent variable ERDF.

Table 17 shows the calculated values of the correlation matrix between the independent variables, specifically the financial instruments under the European Structural and Investment Funds. Here, extremely high correlation values between EU financial instruments are observed.

Table 17. Correlation matrix.

	<i>CF</i>	<i>EAFRD</i>	<i>EMFF</i>	<i>ERDF</i>	<i>FEAD</i>
CF	1				
EAFRD	0.997077	1			
EMFF	0.959877	0.967914	1		
ERDF	0.996749	0.998336	0.97036	1	
FEAD	0.993139	0.995791	0.946682	0.991018	1

Taking into account the high standard errors of the regression coefficients for this observed phenomenon, this leads to the conclusion that there is multicollinearity between the independent variables, which makes it impossible to use a multiple regression model to determine the specific impact of each financial instrument on the gross domestic product of Bulgaria [10]. Multicollinearity causes imprecise estimates of coefficient values, resulting out-of-sample estimates [11-13]. And if the pattern of multicollinearity in the new data differs from that in the data that was fitted, such extrapolation can lead to large errors in the predictions [14-16].

3. Results

The main conclusions of the study can be summarized as follows:

- The average amount of funds absorbed under the European Structural and Investment Funds by the Bulgarian economy for 2014-2022 amounts to 33.4%. This gives Bulgaria the unenviable 20th place out of 28 EU countries;
- It can be seen that for the analyzed period in Bulgaria, a sinusoidal increase was registered in the average size of the amounts absorbed on an annual basis (from 0.17% in 2015 to 64.63% in 2022), which speaks of the improved administrative capacity of individual governments and local administration.
- The disbursed funds under individual European funds have a powerful influence on the dynamics of Bulgaria's GDP for 2014 – 2022. Research shows strong correlations (correlation coefficients between 0.928 and 0.99) across all funds. All estimated parameters are statistically significant at levels between 0.34% and 0.00006%. The studied relationships are dominated by linear ones, except the European Maritime and Fisheries Fund (EMFF), where a logarithmic model ($R^2 = 0.95$) is observed.
- A strongly pronounced multicollinearity is observed in relationships between the absorbed European funds, which makes it impossible to determine the specific influence of each financial instrument on the gross domestic product of Bulgaria.

4. Conclusions

It is obvious that the European funds through which the EU implements its environmental policies have a positive effect on the economic development of the country. The main key finding of the research conducted is that one of the main advantages of using European funds is the added value that revolving instruments have over grants in terms of the efficient use of public resources. Repayable forms of support can also act as an incentive for better quality investments, as investments must be economically viable so that the final recipient can repay the support provided. Limited access to finance is identified as a problem, and the efficient use of public funds should be one of the EU's priorities.

The correct realization of environmental policies requires a well-functioning, cost-effective institutional system and adequate administrative capacity. The inclusion of different fund managers creates wider access for SMEs as they are able to use their range of expertise to reach more companies in need of funding. However, mandatory public procurement in the selection of appropriate beneficiaries does not always support this approach. The practice so far shows that it is necessary to avoid excessive formalization of the process and create conditions for higher competition and increasing efficiency in financing in priority sectors.

Although often used for working capital rather than investment financing, these funds help mitigate the negative effects of the green transition in many regions.

There is evidence that environmental policy funds have generated significant leverage for their beneficiaries and provide a financial resource for reinvestment. Within the framework of the existing structures, they minimize operating costs and help to accelerate the implementation of the planned eco-friendly activities.

Last but not least, it should be noted that these European funds have enabled knowledge transfer and capacity building in the field of environmental economics and decarbonization.

This publication was prepared under INVEST FOR EXCELLENCE IN REGIONAL SUSTAINABILITY (INVEST4EXCELLENCE) project. The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101035815. Responsibility for the information and views set out in this paper lies entirely with the authors.

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