

Econometric Evaluation of the European Union's Progress in Environmental Protection Through the Lens of Economic Well-Being

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Abstract. *This paper aims to analyze, through econometric methods, the relationship between economic well-being and the progress indicators of the European Union in the field of environmental protection. The aim is to assess to what extent economic growth can coexist with reducing the negative impact on the environment, thus providing a framework for more effective public policies. In order to demonstrate the existing link between the indicators for measuring the progress of the European Union to protect the environment, we extracted one of each, thus performing a correlation analysis between them and economic well-being. Economic well-being was represented by the GDP/capita indicator. In this analysis, we used both the Pearson correlation index and the Spearman correlation index. The analyzed period is the period of 2012-2021. The analysis carried out has as a reference the level of the EU-27 indicator from each variable selected in the sample.*

Keywords: economic well-being, sustainable development, sustainable development indicators, econometric evaluation

JEL Classification: Q01, C50

1. Introduction

In the current context of sustainable development, the correlation between economic well-being and environmental protection is a topic of major interest to both researchers and policy makers. The European Union (EU) is firmly committed to promoting a model of economic progress that integrates environmental objectives, which has led to the development of specific indicators to measure this progress. These indicators, such as greenhouse gas emissions, the recycling rate or the use of renewable resources, are essential for monitoring efforts to transition to a green economy.

The sustainable management of natural resources is a priority, and European funds can be used to support projects that promote the circular economy, waste reduction and recycling. Through these investments, the transition to an economic model that minimizes the impact on the environment and exploits resources in a sustainable way is encouraged.

2. Analysis of the correlation between economic well-being and the indicators for measuring the progress of the EU to protect the environment

In order to demonstrate the existing link between the indicators measuring the progress of the EU to protect the environment, we extracted one of each, thus performing a correlation analysis between them and economic well-being. Economic well-being was represented by the GDP/capita indicator.

We performed the correlation analysis with the SPSS statistical program and used both the Pearson correlation index and the Spearman correlation index.

The analyzed period is 2012 – 2021, although we would have liked to reach the level of 2022, but not all indicators are reported by Eurostat until this date. The analysis carried out has as a reference the level of the EU-27 indicator from each variable selected in the sample.

The variables used are reflected in the following table:

Table 2.1 – Variables used

Variables	Name	Variable type
V1	GDP/capita	dependent
V2	Air emissions by resident units (manufacturing activities and households)	independence
V3	Employment in the environmental goods and services sector	independence
V4	Production, value added and exports in the environmental goods and services sector	independence
V5	Investments in environmental protection throughout the economy	independence
V6	Key indicators of physical energy flow accounts	independence
V7	Material flows for the circular economy	independence
V8	Environmental tax revenues	independence
V9	Natura 2000 protected areas	independence
V10	Waste management, except for major mineral waste, through waste management operations	independence
V11	Waste management by waste management operations and type of material	independence
V12	Households - level of internet access	independence
V13	Gross and net production of electricity and derived heat, by type of installation and operator	independence
V14	GERD by performance sector	independence

Source: Table created with data processed in Excel

The first analysis carried out is therefore the analysis using the Pearson correlation coefficient, a coefficient that reflects the intensity and type of connection between the variables. The first analysis resulting and reflected by SPSS is descriptive statistics, which is reflected in the following table:

Table 2.2 - Descriptive statistics

	Average	Standard deviation	No variables
V1	10.18503537864768	.043329066885488	10
V2	15.98921856975454	.063902893657336	10
V3	15.3331201218613	.05258534081655	9
V4	13.46470122450161	.100883883321198	9
V5	10.91546625796792	.084345312968531	9

V6	16.93826338975207	.057898222263714	7
V7	10.5887344227498	.02702793013995	9
V8	12.62972827229396	.059875928594655	10
V9	15.23437011990733	.000000000000001	8
V10	20.3334651447433	.03052342025960	10
V11	14.38824682108493	.029731000390116	9
V12	4.4466457983621	.06276642243581	9
V13	14.88245346721040	.017113445506244	10
V14	12.54646340701979	.110327656769334	9

Source: Table processed in SPSS

For all variables, the average value was far above the standard deviation, which further argues the statistical relevance of the study. It should be noted that N, although it should be equal to 10 for all variables, there were situations when Eurostat did not provide all the information. At the same time, we specify the fact that the heterogeneity as a unit of measure of the variables determined the need to apply a natural logarithm on them.

The Pearson correlation level is reflected in the following table:

Table 2.3 - Pearson Correlation Level

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14
V1 Pearson Correlation	1	-.515	.548	.786(*)	.456	-.413	.797(*)	.979(*)	.(a)	-.098	-.323	.870(***)	.130	.893(**)
V1 Sig. (2-tailed)		.128	.126	.012	.217	.358	.010	.000	.	.787	.396	.002	.720	.001
V1 N	10	10	9	9	9	7	9	10	8	10	9	9	10	9
V2 Pearson Correlation	-.515	1	.803(**)	.794(*)	.722(*)	.884(**)	-.567	-.427	.(a)	.644(*)	.874(*)	-.772(*)	.730(*)	-.763(*)
V2 Sig. (2-tailed)	.128		.009	.011	.028	.008	.111	.219	.	.045	.002	.015	.017	.017
V2 N	10	10	9	9	9	7	9	10	8	10	9	9	10	9
V3 Pearson Correlation	.548	.803(**)	1	.928(**)	.600	.975(**)	.518	.413	.(a)	-.435	.868(*)	.875(***)	-.492	.890(**)
V3 Sig. (2-tailed)	.126	.009		.000	.115	.000	.188	.270	.	.241	.005	.004	.179	.003
V3 N	9	9	9	9	8	7	8	9	8	9	8	8	9	8
V4 Pearson Correlation	.786(*)	.794(*)	.928(**)	1	.585	.909(**)	.632	.685(*)	.(a)	-.231	.753(*)	.949(***)	-.383	.975(**)
V4 Sig. (2-tailed)	.012	.011	.000		.128	.005	.093	.042	.	.550	.031	.000	.309	.000
V4 N	9	9	9	9	8	7	8	9	8	9	8	8	9	8
V5 Pearson Correlation	.456	.722(*)	.600	.585	1	-.456	.778(*)	.314	.(a)	-.252	-.455	.575	-.414	.671(*)
V5 Sig. (2-tailed)	.217	.028	.115	.128		.303	.014	.410	.	.513	.219	.105	.268	.048
V5 N	9	9	8	8	9	7	9	9	8	9	9	9	9	9
V6 Pearson Correlation	-.413	.884(**)	.975(**)	.909(**)	-.456	1	-.310	-.249	.(a)	.642	.916(*)	-.908(***)	.541	-.854(*)
V6 Sig. (2-tailed)	.358	.008	.000	.005	.303		.499	.590	.	.120	.004	.005	.210	.014

	N	7	7	7	7	7	7	7	7	7	7	7	7	7	
V7	Pearson Correlation	.797(*)	-.567	.518	.632	.778(*)	-.310	1	.722(*)	.(a)	-.188	-.410	.763(*)	-.037	.819(**)
	Sig. (2-tailed)	.010	.111	.188	.093	.014	.499	.028	.	.628	.274	.017	.926	.007	
	N	9	9	8	8	9	7	9	9	8	9	9	9	9	9
V8	Pearson Correlation	.979(**)	-.427	.413	.685(*)	-.314	-.249	-.722(*)	1	.(a)	-.001	-.218	.793(*)	.190	.804(**)
	Sig. (2-tailed)	.000	.219	.270	.042	.410	.590	.028	.	.998	.573	.011	.599	.009	
	N	10	10	9	9	9	7	9	10	8	10	9	9	10	9
V9	Pearson Correlation	.(a)	.(a)	.(a)	.(a)	.(a)	.(a)	.(a)	.(a)	.(a)	.(a)	.(a)	.(a)	.(a)	.(a)
	Sig. (2-tailed)	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	8	8	8	8	8	7	8	8	8	8	8	8	8	8
V10	Pearson Correlation	-.098	.644(*)	-.435	-.231	-.252	.642	-.188	-.001	.(a)	1	.595	-.450	.413	-.426
	Sig. (2-tailed)	.787	.045	.241	.550	.513	.120	.628	.998	.	.091	.224	.235	.254	
	N	10	10	9	9	9	7	9	10	8	10	9	9	10	9
V11	Pearson Correlation	-.323	.874(**)	.868(**)	-.753(*)	-.455	.916(**)	-.410	-.218	.(a)	.595	1	.704(*)	.711(*)	-.641
	Sig. (2-tailed)	.396	.002	.005	.031	.219	.004	.274	.573	.	.091	.034	.032	.063	
	N	9	9	8	8	9	7	9	9	8	9	9	9	9	9
V12	Pearson Correlation	.870(**)	-.772(*)	.875(**)	.949(**)	.575	-.908(**)	.763(*)	.793(*)	.(a)	-.450	.704(*)	1	-.187	.984(**)
	Sig. (2-tailed)	.002	.015	.004	.000	.105	.005	.017	.011	.	.224	.034	.630	.000	
	N	9	9	8	8	9	7	9	9	8	9	9	9	9	9
V13	Pearson Correlation	.130	.730(*)	-.492	-.383	-.414	.541	-.037	.190	.(a)	.413	.711(*)	-.187	1	-.143
	Sig. (2-tailed)	.720	.017	.179	.309	.268	.210	.926	.599	.	.235	.032	.630	.713	
	N	10	10	9	9	9	7	9	10	8	10	9	9	10	9
V14	Pearson Correlation	.893(**)	-.763(*)	.890(**)	.975(**)	.671(*)	-.854(*)	.819(*)	.804(*)	.(a)	-.426	-.641	.984(**)	-.143	1
	Sig. (2-tailed)	.001	.017	.003	.000	.048	.014	.007	.009	.	.254	.063	.000	.713	
	N	9	9	8	8	9	7	9	9	8	9	9	9	9	9

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

a Cannot be computed because at least one of the variables is constant.

Source: Table processed in SPSS

Correlation analysis with the Pearson correlation coefficient led us to conclude the following:

- A significant, inverse correlation between the dependent variable V1 and the independent variable V2, the correlation level being -0.515.

- A direct, significant correlation between the dependent variable V1 and the independent variables V3, V4, V7, V8, V12 and V14.

V10	Correlation Coefficient	.025	.172	-.068	-.102	.000	.092	-.017	.049	.	1.000	.407	-.339	.049	-.220
	Sig. (2-tailed)	.946	.634	.862	.795	1.000	.845	.965	.893	.	.	.277	.372	.893	.569
	N	10	10	9	9	9	7	9	10	8	10	9	9	10	9
V11	Correlation Coefficient	-.533	.733 (*)	-.643	-.643	-.567	.607	-.650	-.483	.	.407	1.000	-.733 (*)	.467	.717 (*)
	Sig. (2-tailed)	.139	.025	.086	.086	.112	.148	.058	.187	.	.277	.	.025	.205	.030
	N	9	9	8	8	9	7	9	9	8	9	9	9	9	9
V12	Correlation Coefficient	.867 (**)	-.767 (*)	.976 (**)	.976 (**)	.683 (*)	-.964 (**)	.767 (*)	.800 (**)	.	-.339	.733 (*)	1.000	-.067	.983 (**)
	Sig. (2-tailed)	.002	.016	.000	.000	.042	.000	.016	.010	.	.372	.025	.	.865	.000
	N	9	9	8	8	9	7	9	9	8	9	9	9	9	9
V13	Correlation Coefficient	.067	.612	.067	-.017	-.533	.071	-.317	.115	.	.049	.467	-.067	1.000	-.017
	Sig. (2-tailed)	.855	.060	.865	.966	.139	.879	.406	.751	.	.893	.205	.865	.	.966
	N	10	10	9	9	9	7	9	10	8	10	9	9	10	9
V14	Correlation Coefficient	.933 (**)	-.733 (*)	.952 (**)	.952 (**)	.700 (*)	-.929 (**)	.800 (**)	.883 (**)	.	-.220	.717 (*)	.983 (**)	-.017	1.000
	Sig. (2-tailed)	.000	.025	.000	.000	.036	.003	.010	.002	.	.569	.030	.000	.966	.
	N	9	9	8	8	9	7	9	9	8	9	9	9	9	9

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Source: Table processed in SPSS

Correlation analysis with the Spearman correlation coefficient led us to conclude the following:

- A significant inverse correlation was established between V1 and the independent variables V2, V6 and V11.
- Significant direct correlations resulted between the dependent variable V1 and the independent variables V3, V4, V5, V7, V8, V12 and V14.

3. Estimation of the multiple linear regression model

Considering the statistical relevance of the two coefficients, we take into account the level of correlation established by the Pearson coefficient. We took as variables in order to create the econometric model only those with significant correlation results with a sig significance threshold below 0.05.

And in this case the first resulting analysis is the descriptive statistics, analysis reflected in the following table:

Table 2.5 - Descriptive statistics

	Average	Standard deviation	N
V1	10.18503537864768	.043329066885488	10
V4	13.46470122450161	.095114237345135	10
V7	10.5887344227498	.02548217691119	10
V8	12.62972827229396	.059875928594655	10

V12	4.4466457983621	.05917675058024	10
V14	12.54646340701979	.104017912338690	10

Source: Table processed in SPSS

Considering that the average is well above the standard deviation for all the variables selected in order to obtain the regression model, the econometric model that will result at the end is considered relevant.

Next, the variables selected in order to obtain the econometric model are reflected, the variables excluded by the program as not relevant for the model as well as the enter method, selected method for creating the econometric model in SPSS.

All this is reflected in the following table:

Table 2.6 - Variables entered/excluded

Example	Input variables	Excluded variables	Method
1	V14, V8, V4, V7, V12(a)	.	Enter

a All requested variables entered.

b Dependent Variable: V1

Source: Table processed in SPSS

It can be seen from the table that all the independent variables where a correlation was established with the dependent variable were kept in the econometric model. So we will have one dependent variable and 5 independent variables.

Another relevant analysis from an econometric point of view is the analysis given by the summary model, which is reflected in the following table:

Table 2.7 - Model Summary(b)

Example	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					Sig. F Change	R Square Change	F Change	df1	df2		Sig. F Change
1	1.000(a)	.999	.998	.001833917895991	.999	1003.981	5	4	.000	2.301

a Predictors: (Constant), V14, V8, V4, V7, V12

b Dependent Variable: V1

Source: Table processed in SPSS

Both the level of R and R2 and Durbin-Watson give special relevance and economic significance to the regression model we are about to obtain.

The next test for validating the regression model is the ANOVA test, which is reflected in the following table:

Table 2.8 - ANOVA(b)

Example	Sum of Squares	df	Mean Square	F	Sig.
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1	Regression	.017	5	.003	1003.981	.000(a)
	Residual	.000	4	.000		
	Total	.017	9			

a Predictors: (Constant), V14, V8, V4, V7, V12

b Dependent Variable: V1

Source: Table processed in SPSS

In the ANOVA test, F has a special significance where we observe a value of 1003.981, which demonstrates the relevance and correctness of the statistical processing of the variables in order to obtain the multiple linear regression.

The last stage in the realization of the regression model is the determination of the regression coefficients. All these data are reflected in the following table:

Table 2.9 - The coefficients of the regression function

Example	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta	B	Std. Error
1 (Constant)	.596	.404		1.473	.215
V4	.010	.012	.023	.901	.418
V7	.045	.050	.027	.908	.415
V8	.576	.015	.796	38.677	.000
V12	-.197	.064	-.269	-3.067	.037
V14	.205	.040	.492	5.082	.007

a Dependent Variable: V1

Source: Table processed in SPSS

The resulting regression model is of the form:

$$\text{GDP/capita} = 0,010 \cdot \text{V4} + 0,045 \cdot \text{V7} + 0,576 \cdot \text{V8} - 0,197 \cdot \text{V12} + 0,205 \cdot \text{V14} + 0,596 + \varepsilon$$

Where: ε – model error.

This regression model suggests a relationship between GDP per capita (GDP/capita) and a number of independent variables (V4, V7, V8, V12, V14).

Regarding the above correlation, we can interpret as follows:

V4: Production, value added and exports in the environmental goods and services sector (coefficient: 0.010)

- Growth in the environmental goods and services sector has a positive impact on GDP/capita, but the contribution is modest.

- This indicates that green sector development, while valuable for sustainability, still does not play a central role in generating economic well-being.

V7: Material flows for the circular economy (coefficient: 0.045)

- A positive coefficient of 0.045 suggests that improving material flows within the circular economy contributes to increasing GDP per capita.

- The circular economy, by reducing waste and reusing materials, can generate economic efficiencies and bring tangible economic benefits.

V8: Environmental tax revenues (coefficient: 0.576)

○ This is the largest positive coefficient in the model, indicating a significant relationship between environmental tax revenue and GDP/capita.

○ Ecological fiscal policies, well implemented, contribute significantly to economic well-being.

V12: Households – level of internet access (coefficient: -0.197)

○ The negative coefficient suggests that, in the context of the model, an increase in the level of Internet access may have a negative associated effect on GDP per capita.

○ This seemingly counterintuitive relationship could reflect indirect costs or discrepancies in the efficient use of Internet access. For example, access does not guarantee productive use, and in some situations, up-front costs or inefficient use of technology can affect economic growth.

V14: GERD (Gross Research and Development Expenditure) by performance sector (coefficient: 0.205)

○ The positive coefficient suggests that investment in research and development contributes to the growth of GDP per capita.

○ This result underlines the importance of innovation and technological progress as engines for economic growth, especially when they are directed to performing sectors.

These interpretations provide a basis for future strategies, emphasizing the importance of a sustainable, innovative and environmentally oriented economy.

7. Conclusions

The econometric analysis of the correlation between GDP per capita and variables associated with the progress of the European Union in environmental protection highlights significant relationships, which emphasize the interdependence between economic development and environmental priorities. Environmental tax revenues have the largest positive impact on GDP per capita, indicating that green tax policies play a central role in both stimulating the economy and protecting the environment.

Also, material flows from the circular economy and activities in the environmental goods and services sector contribute positively to economic growth. These results suggest that the green economy and the circular economy represent areas with significant potential for sustainable development. At the same time, investments in research and development have a relevant positive impact, confirming that innovation and support of performing sectors can become essential engines of long-term economic well-being.

A less intuitive result is the negative effect of household Internet access on GDP per capita. This aspect requires further investigation, as it could reflect discrepancies in technology use or costs associated with access, rather than the actual potential of digitization to boost economic growth.

Overall, the analysis underlines the importance of policies that promote the transition to a green economy, strengthening environmental tax revenues, investing in research and innovation, and the effective use of digital technologies. These directions can contribute to achieving the objectives of sustainable economic growth and environmental protection in the European Union.

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