Socio-Economic Modelers of Environmental Performance: Empirical Evidence from the European Union

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Abstract. *The environment represents one of the main collective responsibilities of the current period, marked by accelerated economic development. In the context of increasingly pronounced ecological deterioration and less sustainable practices, the level of involvement of decision-makers and the population has become a great challenge. Beyond legislative mechanisms, which can help states improve their environmental performance, an important role is also played by knowing the direct and indirect factors that can act on this performance. The specialized literature approaches environmental performance from various angles, most studies being focused on analysis tools and how to measure it, and less on the factors that can shape it at the national level. In this context, our approach takes into account the synergies between the environmental performance at the level of the European Union member states (measured by the Environmental Performance Index - EPI) and the selected economic-social factors. The selected sample includes the 27 member states of the European Union, the analysis being carried out for the period 2006-2022. The research methodology is based on Bayesian network analysis through Gaussian graphical models. The obtained results show that environmental performance is closely related to economic and social factors, through positive or negative connections, the relationship being bidirectional. Our approach is thus intended to be useful in providing a series of information to support decision-makers both in the implementation of environmental policy at the European level and in the adjustment of some national regulations.*

Keywords: environmental performance, European Union, economic and social factors, Bayesian network analysis.

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Introduction

The accelerated growth of economies, urbanization and industrialization have generated a series of environmental problems, especially since the 60s (Arbolino et al., 2018). The causes that led to the degradation of the environment are multiple, part of them being attributed to the human factor, technological progress, but also to the reduced possibilities of the less developed states to ensure an optimal balance between the precarious financial resources and the costs related to environmental protection . The large-scale use of limited resources, energy consumption and, implicitly, the increase in greenhouse gas emissions, but also the development of polluting economic sectors (transport and industry) have caused a series of environmental disturbances, and the authorities around the world they have become more concerned with adopting policies and regulations to limit harmful effects.

In the specialized literature, since the 60s, approaches to environmental protection have evolved from simple legal regulations to concrete actions based on companies' initiatives to adopt sustainable practices that reduce the harmful effects of activities on the environment (Esty, 2004). Gradually, more and more environmental information was collected from companies, which led the authorities to adopt new regulations through which companies and the population could adopt more responsible behavior.

The bilateral relationship between the accelerated economic development and the natural environment led to an ecological crisis that determined the holding in 1992, in Rio de Janeiro in Brazil, of the UN Conference on Environment and Development, during which the concept of "development" was discussed for the first time durable". The results were quantified in the creation of a set of programs for sustainable development with the aim of adapting national legislation to the requirements of environmental issues (eg, the Kyoto Protocol, the Earth Charter, etc.).

The natural environment therefore belongs to everyone. As such, its protection calls, to a great extent, for a collective action that involves both institutional factors and economic agents and the population. All these actors involved have a responsibility to ensure that the costs and benefits of actions that affect the environment are taken into account in decisions at the governmental and individual level.

In this context, given the global and European concerns to promote the principles of sustainable development, it becomes opportune to analyze the synergistic link between the environmental performance of states and the factors that can affect it both positively and negatively.

Given that environmental degradation is a complex problem generated by a series of both human and technological factors, in this paper we will analyze how the environmental performance at the level of the member states of the European Union is shaped by a series of specific factors. The analysis covers all 27 member states of the European Union, the period being 2006-2022. The research methodology is based on Bayesian Network Analysis which aims to evaluate the direct and indirect influences between the selected variables.

The work is structured in five sections. The introduction briefly describes the general context of environmental performance and the issue of environmental protection followed, in the second section, by a brief analysis of the relevant specialized literature. The third section of the paper presents the data and indicators selected for the empirical analysis, at the level of the member states of the European Union, as well as the research method used. Based on the econometric modeling, the results obtained and their correlation with the results of other researches are presented in the next section. The paper ends with a series of relevant conclusions that also include the limitations of the research.

Literature review

Environmental performance is a complex subject, debated both by theorists and by experts and governments. A number of relevant studies in the literature treat environmental performance as a constant concern of developed states (Jahn, 1998; Carrión-Flores & Innes, 2010; Haque & Ntim, 2018), while less developed states assign more importance reduced, especially due to the financial constraints generated by ensuring environmental sustainability (Arbolino et al, 2018).

The specialized literature focuses on a series of determinants of environmental performance, starting from the analysis of the causes of climate change (Crowley, 2000; Hegerlet al, 2019), the analysis of the determinants of sustainable resource management (Jin, 2023), analysis of waste collection and management (Beliën et al, 2014; Pires et al, 2019), but also from the impact of pollution on human health (Susanto, 2020).

In order to evaluate and compare the environmental performance of the states, in the specialized literature a series of composite indicators are used that come from the synthesis of several specific indicators that cover a wide range of interconnections between the environmental, social and economic fields (Gareiou et al, 2023). Thus, a series of studies in specialized literature focuses on the analysis of the Environmental Sustainable Index (ESI), which accurately reflects the progress of the compared states towards higher environmental sustainability (Birgani & Moghaddam, 2018; Shah et al., 2019).

Other authors considered it more relevant to compare the environmental performance of states by using the Sustainable Development Goals Index (SDG Index), considering that its scope is much wider (Schmidt-Traub et al, 2017; Diaz- Sarachaga et al., 2018; Dasgupta et al., 2022).

On the other hand, based on more complex data and evidence, derived from information taken from more than 180 countries and based on 40 performance indicators that facilitate comparison between states, other authors analyze the environmental performance of states using the Performance Index of the Environment (Environmental Performance Index - EPI) (Kortelainen, 2008; Hsu et al, 2013; Zuo et al, 2017; Pimonenko et al, 2018; Wolf et al, 2022).

Kortelainen (2008) analyzed EPI dynamics at the level of 20 states for the period 1990-2003 using a Malmquist index approach, making a shift to a much more dynamic framework for analyzing environmental performance. The author's conclusions suggested that the environmental performance of the analyzed states was influenced by the progress made in environmental technologies. Hsu et al (2013) analyzed the determinants that contribute to explaining differences in performance among the 180 countries analyzed, the authors' conclusion being that there are a number of inequalities between countries in terms of progress towards achieving environmental goals.

Regarding factors influencing environmental performance, a number of studies focus on how alternative energy sources are used and on the effects of environmental technology efficiency in reducing pollution impacts (Lund, 2007; Abolhosseini, Heshmati & Altmann, 2014; Riti). & Shu, 2016 Drăcea et al., 2020). In addition, the literature also examines the economic aspects of environmental performance, including the costs and benefits of environmental protection measures (Esty & Porter, 2005; Converse, 2011; Gallego-Álvarez et al., 2014; Pimonenko et al., 2018), the results suggesting that less developed states face a number of financial challenges related to compliance with environmental protection principles.

Thomakos and Alexopoulos (2016) examined the relationship between carbon intensity as a measure of environmental performance and EPI. They researched whether carbon intensity can provide relevant data for environmental performance assessment, using empirical data from 150 states at the level of 2012. The obtained results suggest that the variable that explains the EPI level the most is carbon intensity, between them there is a relationship reverse.

Another factor that can influence environmental performance is the behavior of consumers and businesses, as consumer choices and business practices can directly affect the environment (Noja et al, 2023).

From a different angle, a number of studies have been conducted in the literature to examine the relationships between environmental performance, globalization (as measured by the KOF index) and GDP/capita. These studies investigate the ways in which these factors may be correlated or influence each other (Tausch & Heshmati, 2008; Gallagher, 2009; Wang et al, 2021; Arshed al., 2024).

Using panel data for 148 countries from 2001 to 2018, Wang et al (2021) document the effects of globalization on environmental performance by measuring multidimensional aspects of globalization using the KOF index and the environmental performance index. Empirical findings suggest that environmental performance depends directly on globalization, with a strong direct relationship between the two indicators. In the same direction, Arshed et al (2024) explore the quality of the environment (measured by the EPI index) in correlation with well-being, urbanization and globalization (measured by the KOF index). The results of the study show that in the long run, increased urbanization and globalization improve environmental performance. Similar results are obtained by other authors (Shahbaz et al, 2018; Noja et al, 2022) who emphasize the existence of beneficial effects of globalization on environmental performance.

Other studies in the literature have also focused on the causal relationship between energy use and economic growth (Dagher & Yacoubian, 2012; Azam et al., 2015). The findings obtained by the authors indicate that there is no significant causal relationship between long-term energy consumption and GDP dynamics in less developed countries. Almarafi, Khudari & Abdullah (2023) provide a critical analysis of the relationship between EPI, financial development and economic growth. The study concludes that environmental performance and sustainability are essential aspects for stimulating economic growth and development in industrialized countries. Furthermore, the link between environmental performance and demographic factors of nations is complex and may vary according to specific contexts.

Finally, the specialized literature also identifies a series of social factors (eg, the level of poverty, population density, unemployment, etc.) that can have an indirect impact on the environmental performance of states viewed from the perspective of achieving sustainable development objectives. Thus, research on the relationship between poverty and environmental performance provides a series of clues related to how poverty reduction can contribute to an improvement in environmental performance (Rizk & Slimane, 2018; Rai, 2019; Azizi et al, 2022). On the other hand, a series of studies (Pauleit & Duhme, 2000; Roux et al, 2011; Lau et al, 2018) analyze the link between population density and environmental performance, both at the national level and at the level of cities and communities local. The results obtained by the authors suggest, in their vast majority, the existence of an inverse connection between environmental performance and population density.

In short, the specialized literature offers a series of relevant perspectives and conclusions regarding environmental performance and the factors that can affect its level. At the same time, the evaluation of the states according to the recorded environmental performance allows us to identify the existing gaps between the states regarding the fulfillment of the sustainable development objectives. At the same time, identifying its influencing factors can be an effective way for states to adjust their environmental policies and, implicitly, improve environmental performance.

Methodology

The research methodology is based on the analysis of Bayesian networks through Gaussian graphic models, with the help of which the synergies between different economic and social factors will be analyzed (standard of living, poverty rate, population density, energy consumption from renewable sources, energy efficiency, degree of globalization of states, the level of greenhouse gas emissions) and the environmental performance of EU member states (measured by the Environmental Performance Index – EPI).

The analysis is carried out for a sample that includes all 27 member states of the European Union, the analysis period being 2006-2022. The variables selected and used in the econometric model, as well as the data source and indicator coding are shown in Table 1.

Table 1. Indicators used in the empirical analysis at the EU-27 level, period 2006-2022

No.	Indicators used in the analysis	U.M	Acronym	Data sources
1.	*Environmental Performance Index*	Score (0 to 100 scale)	EPI	Yale Center for Environmental Law & Policy (2024)
2.	*Renewable energy sources*	%	RE	European Commission (2024), Eurostat [NRG_IND_REN]
3.	*At-risk-of-poverty rate by poverty line*	%	POV	European Commission (2024), Eurostat [ILC_LI02]
4.	*KOF Globalisation Index*	Score (0 to 100 scale)	KOF	KOF Swiss Economic Institute (2024)
5.	*Net greenhouse gas emissions*	Tonnes per capita	GES	European Commission (2024), Eurostat [sdg_13_10]
6.	*Energy efficiency*	Million tonnes of oil equivalent (Mtoe)	EE	European Commission (2024), Eurostat [nrg_ind_eff__custom_9282575]
7.	*Real GDP per capita*	Euro per capita	GDP	European Commission (2024), Eurostat [sdg_08_10]
8.	*Population density*	Persons per square kilometer	PD	European Commission (2024), Eurostat [tps00003]

Source: Authors contribution.

The *Environmental Performance Index (EPI)* is a composite index structured on 40 performance indicators covering the environmental, social and economic domains and is used to evaluate and rank 180 countries according to recorded environmental parameters. The EPI is a tool that shows the position of a particular state in terms of achieving its environmental policy objectives (Wolf et al, 2022).

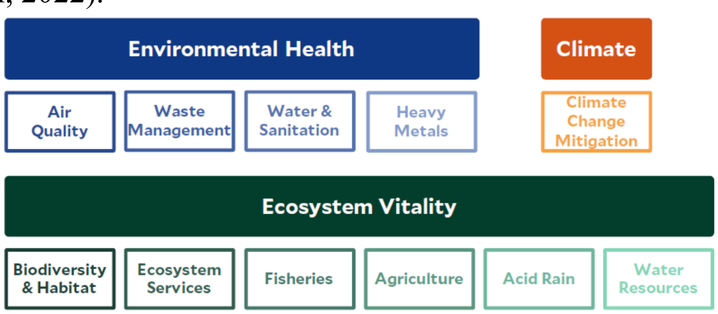


Figure 1. The EPI Framework

Source: https://epi.yale.edu/downloads/epi2022policymakerssummary.pdf.

Renewable energy sources (RE) is an indicator that shows the percentage of renewable energy used by a state in total energy sources. This indicator is useful as it shows the efforts of the analyzed states in reaching the targets regarding the use of renewable energy sources (42.5% of total consumption by the year 2030, according to the revised Directive on energy from renewable sources, 2023).

Risk of poverty rate (POV) represents the share of people who register a monthly income below the poverty risk threshold (https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:At -risk-of-poverty_rate).

Globalization Index (KOF) is a composite index that measures the degree of globalization in the economic, social and political domains (https://kof.ethz.ch/en/forecasts-and-indicators/indicators/kof-globalisation-index.html). This index is available for 190 countries and covers the period from 1970 to 2022.

Net greenhouse gas emissions (GES) is an indicator used to monitor the progress of states in the climate field. This indicator measures total national emissions, from the so-called "Kyoto basket" of greenhouse gases (https://ec.europa.eu/eurostat/cache/metadata/en/ sdg_13_10_esmsip2.htm).

Energy efficiency (EE) is an indicator that shows how effective countries are in their efforts to reduce energy consumption without affecting the comfort of users. This is an important indicator within the EU in the context of the energy transition.

Real GDP per capita (GDP) is a useful indicator to compare a country's economic growth rate. The indicator includes in its composition all public and private consumption, state expenditures, gross investment expenditures and the balance of foreign trade (export-import).

Population density (PD) is an indicator that measures the population level per unit area.

Descriptive statistics for the chosen variables are presented in Table 2.

Table 2.Summary statistics of the data collected

Indicators	RE	EPI	KOF	GES	POV	EE	GDP	PD
Valid	459	234	459	459	454	456	459	324
Mean	19.259	72.685	82.935	9.675	15.830	50.866	14.360	121.926
Standard Deviation	11.846	10.044	4.465	3.804	3.965	72.319	0.923	107.218
Median Absolute Deviation (MAD)	7.552	7.800	4.000	2.100	2.900	17.285	0.740	33.950
MAD robust	11.197	11.564	5.930	3.113	4.300	25.627	1.097	50.334
Minimum	0.149	48.340	71.000	4.500	6.500	0.710	12.130	1.317
Maximum	66.002	91.440	91.000	29.700	26.400	332.750	16.430	512.800

Source: Data processing by authors in JASP.

It is observed that the highest average is recorded by population density (DP), which indicates a high population density in EU member countries. Values for RE ranging between 0.149 and 66.002 suggest to us a great diversity in the production and use of renewable energy among the Member States in the sample. In addition, the standard deviation of 11.846 shows a relatively large variability in the use or production of renewable energy between states.

The largest standard deviation for EE (Energy Efficiency) suggests a significant variation in energy efficiency between states, showing a large dispersion in how EU-27 states use energy.

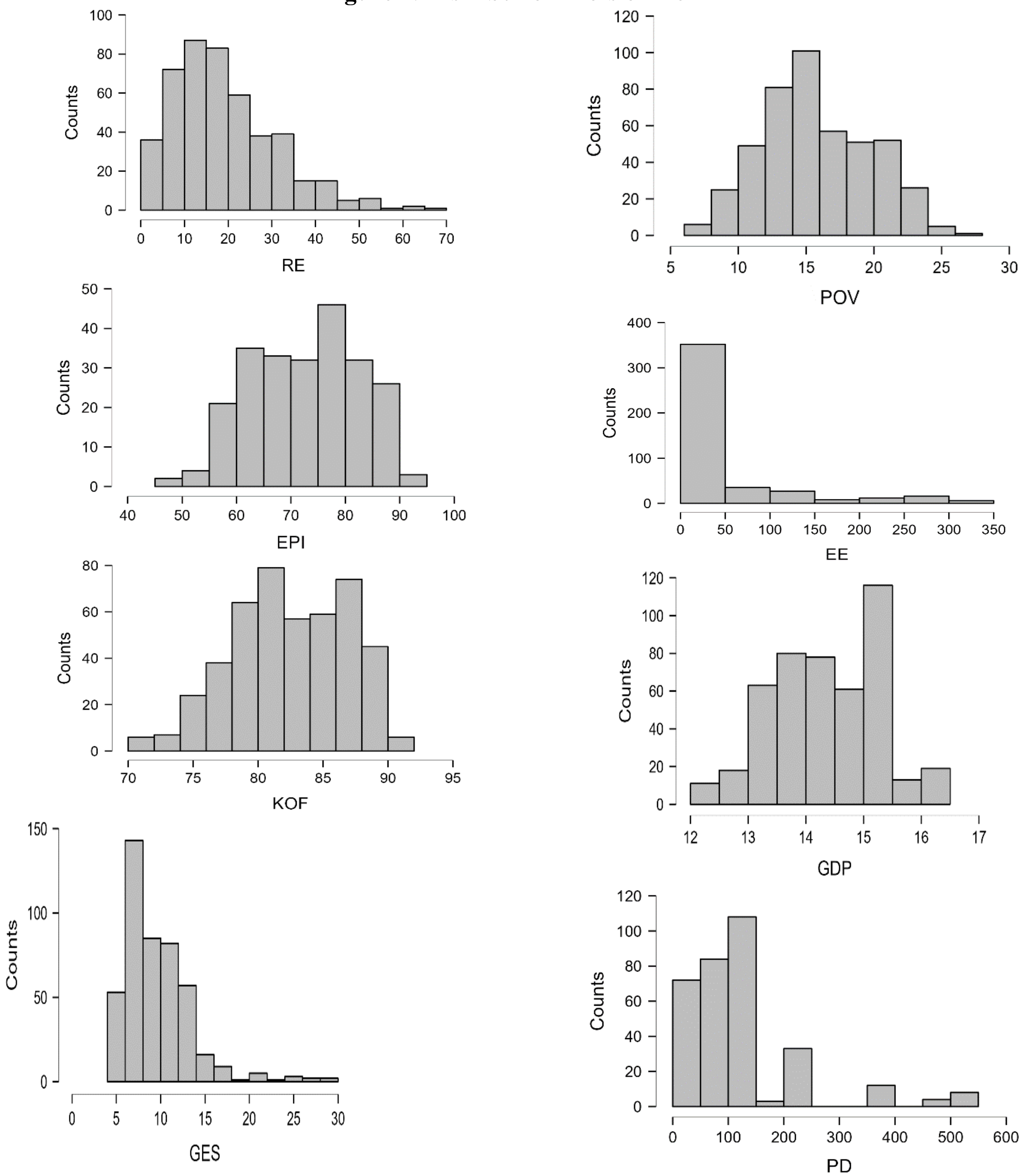
Greenhouse gas (GHG) emissions range from 4.5 to 29.7, with an average of 9,675. The standard deviation of 3.804 suggests that they are relatively similar between the analyzed states, with no considerable differences.

With values between 12.13 and 16.43 and a very small standard deviation (0.923), real GDP/capita shows us some uniformity among European states.

Finally, the largest variation between the minimum and maximum value for EE (Energy Efficiency) indicates that some EU Member States are very efficient, while others are extremely energy inefficient.

Figure 2 shows how the data is distributed in the selected data set. Scatter plots provide a graphical view of the distribution of data that helps understand central tendencies and variability.

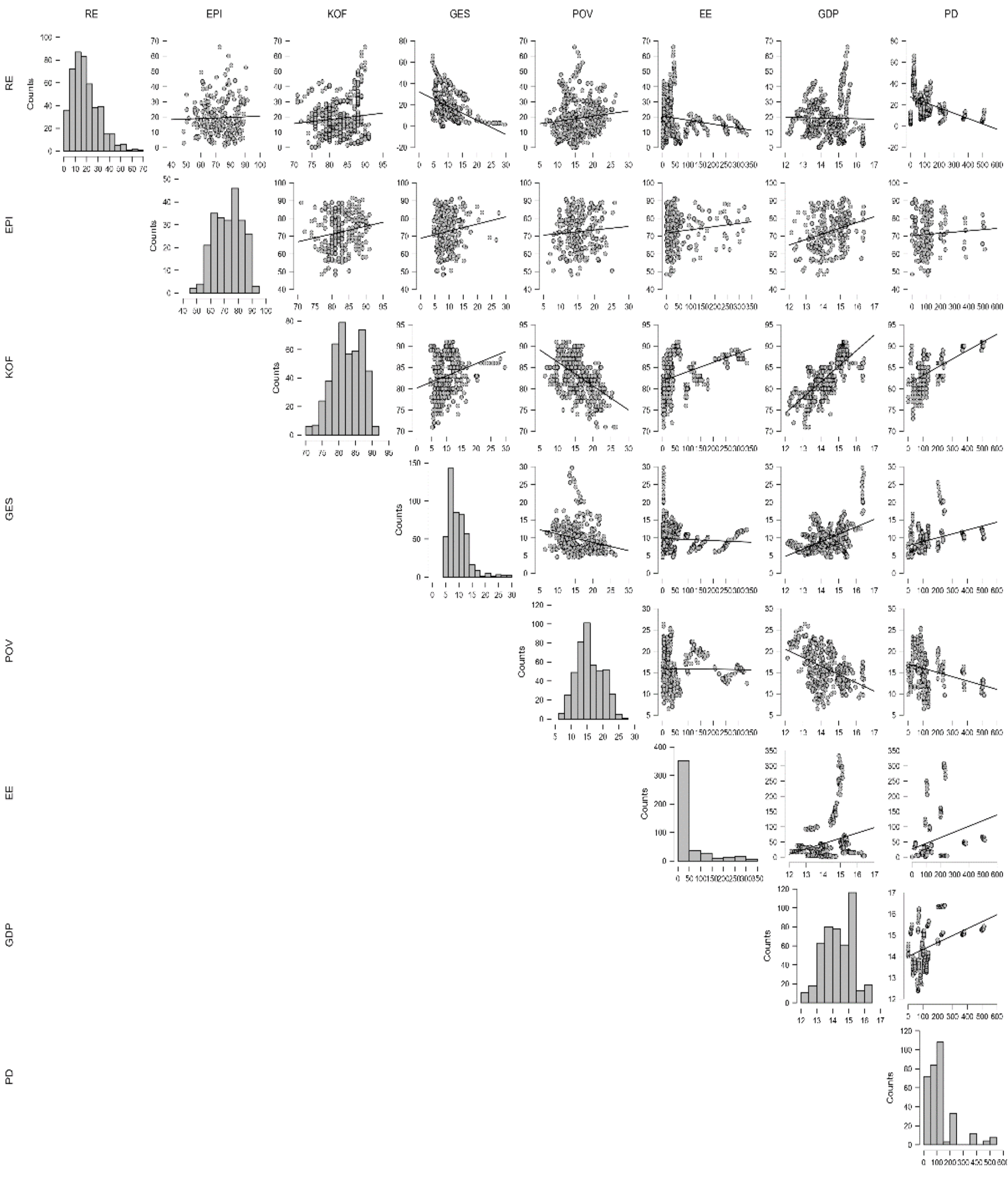
Figure 2. Distribution Plots of the Data



Source: Data processing by authors in JASP.

The correlation between the selected variables is shown using the correlation graphs in Figure 3.

Figure 3. Correlation Plots between the Data



Source: Data processing by authors in JASP.

Based on the correlation graphs, a positive correlation is observed, on the one hand, between RE and EPI, which suggests that increasing the use of renewable energy sources can contribute to improving the environmental performance of the analyzed states and, on the other hand, between EE and GDP, showing that states with higher energy efficiency tend to have higher GDP/capita.

Thus, starting from the existing theoretical bases in the specialized literature, from the previous section, the research effort will be directed towards investigating the interconnections between the variables considered. In this sense, we evaluate two research hypotheses as follows:

• *H1: Economic-social factors and the environmental performance of the EU member states are closely interconnected;*

• *H2: Economic-social factors directly influence environmental performance, the relationship being bidirectional.*

To test the research hypotheses, we will use Bayesian network analysis applied to graphical Gaussian models (GGM) and graphical causal Gaussian models (GCGM), using JASP software. Graphical Gaussian models (GGMs) are used to represent correlation relationships between continuous random variables. These models use the correlation matrix or variance-covariance matrix to describe the connections between variables (Epskamp, 2018).

Graphical Causal Gaussian Models (GCGMs) are extensions of GGMs that add a causality dimension. In GCGM, one tries to identify not only the correlation relationships between variables, but also the direction of causality between them. This is important in understanding and modeling cause and effect in a system (Jeng & Woods, 1991).

Results and discussions

To test the research hypotheses H1 and H2, the correlation network will be constructed indicating the direct or inverse relationships between the variables in the selected data set.

The results of Bayesian Network Analysis, based on GGM, represented in Figure 1, revealed low influences on energy efficiency and socio-economic factors that influence its level (Figure 4).

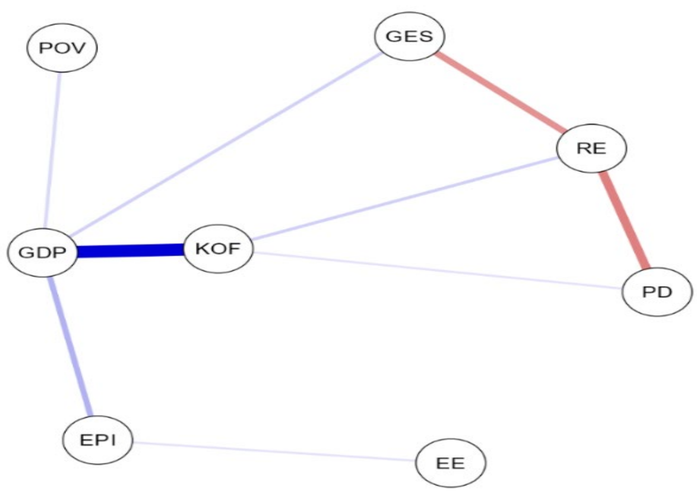


Figure 4. Bayesian Network Analysis results by applying GGMs

Source: Data processing by authors in JASP.

The analysis of the data in Appendix 1 (Table A1) and Figure 4 suggests the existence of a favourable relationship between the level of GDP/capita (GDP) and the degree of globalization

(KOF), as well as between the degree of globalization (KOF), environmental performance (EPI) and energy efficiency (EE). These favourable links show us, on the one hand, that the states that have a higher degree of economic development tend to be the most globalized, and on the other hand, that a better environmental performance is recorded in those states with a higher level of energy efficiency These results are in agreement with those obtained in the specialized literature (Tausch & Heshmati, 2008; Gallagher, 2009; Wang et al, 2021; Noja et al, 2022; Arshed al., 2024).

Quantifying the probability of the existence of links between selected variables in the network analysis (Appendix 1, Table A2) shows us that high greenhouse gas (GHG) emissions are associated with high GDP/capita and low use of renewable energy. On the other hand, a GHG level of 1 indicates high greenhouse gas emissions, and the probability that the variables RE (renewable energy) and GDP are also 1 is 1. On the other hand, the poverty rate (POV), has a probability of 1 when the GDP variable registers level 1, indicating that a high GDP/capita is associated with a low poverty rate.

The variable KOF (level of globalization) has a probability of 1 when the variable GHG (greenhouse gas emissions) is 1, or the variable POV (poverty rate) is 1. This may suggest that high greenhouse gas emissions or poverty can influence the degree of globalization, contrary to Anser et al. (2021), who found an inverse correlation between these indicators.

The variable PD (population dispersion) has a probability of 1 when the variable GDP is 1 or the variable POV (poverty rate) is 0.180. This may indicate that a high GDP/capita or a low poverty rate is associated with a lower population dispersion, in agreement with the results obtained in the literature (Pauleit & Duhme, 2000; Roux et al, 2011; Rizk & Slimane, 2018; Lau et al, 2018; Rai, 2019).

Thus, from the data obtained, it is observed that on environmental performance (EPI), the only variables that have a significant influence are energy efficiency, the level of globalization and the level of GDP/inhabitant, *which suggests that hypothesis H1 is partially fulfilled.*

To test hypothesis H2, we will use Bayesian network analysis based on graphical Gaussian causal models (GCGMs), represented in Figure 5.

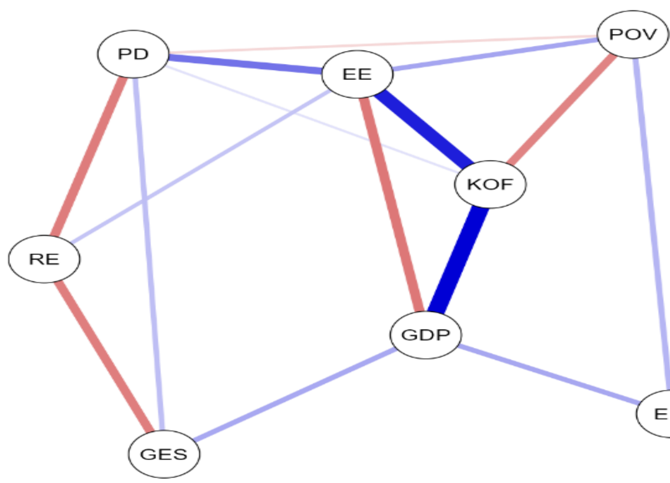


Figure 5. Bayesian Network Analysis results by applying GCGMs

Source: Data processing by authors in JASP.

The analysis of the data in Figure 5 and Table A4 (Appendix 2) shows the existence of a positive link between the level of globalization (KOF) and GDP/capita, on the one hand, and the level of globalization and energy efficiency (EE), on the other hand, being in agreement with the findings obtained by Shahbaz et al. (2018).

Regarding the level of greenhouse gas (GHG) emissions, unfavorable connections are observed with PD (Population Density) and GDP (increasing population density and GDP causes an increase in GHG), according to the findings obtained by Cole & Neumayer (2004), and the favorable ones with the use of renewable energy (RE) (the reduction of RE also mitigates GHG), in accordance with the findings obtained by other authors (Edenhofer et al., 2011; Fuss et al., 2018; Rogelj et al., 2018).

Regarding the environmental performance of the EU member states (EPI), a favorable connection is observed with the standard of living of the population (GDP/inhabitant), and an unfavorable one with the poverty rate (POV). This result suggests that countries with higher GDP/capita also tend to have better environmental performance, but higher EPI also increases poverty.

Based on these results, it can be appreciated that hypothesis H2 is also partially fulfilled.

Conclusion

The present work sought to explore the various shaping factors and the connections between them that can affect the environmental performance of the European Union member states. The analysis was carried out at the level of the 27 EU member states for the period 2006-2022 and started from the premise that the environmental performance of the states is different, although all make considerable efforts to achieve the objectives of sustainable development and reduce the negative effects of degradation the environment.

In this sense, we formulated two research hypotheses that were partially confirmed, respectively: *H1. The economic-social factors and the environmental performance of the EU member states are closely interconnected*, and *H2. Economic and social factors directly influence environmental performance, the relationship being bidirectional*.

The obtained results showed that the only variables that have a significant influence on environmental performance (EPI) are energy efficiency, GDP/capita level and the degree of globalization. Although energy efficiency and GDP/capita may be the most important shapers, there are still other factors that can influence environmental performance, but they can have a rather complex interdependence relationship and the effects can be quite difficult to quantify. In addition, the environmental policies of the member states, investments in environmental technologies, innovation and the level of education of the population can generate a series of positive changes in the way EPI is quantified.

Based on the results obtained, we appreciate that the member states of the European Union can adopt a series of measures to improve their environmental performance. Thus, given that a direct, favorable link between energy efficiency and environmental performance has been found, it is recommended to accelerate the implementation of measures to expand distribution networks that integrate renewable energy sources as efficiently as possible. Also, in accordance with Article 194 of the Treaty on the Functioning of the European Union, the member states should make concerted efforts to reduce greenhouse gas emissions and respect the assumed national targets. It is also recommended that the member states increase the level of investments for innovative solutions in the field of environmental technologies and achieve a correlation as efficient as possible between the investment needs and the specificity of the economy.

Of course, the work also contains certain limitations that we are aware of. A first limitation of the research is given by the choice of environmental performance modelers, which is not exhaustive. Another limitation of the research is represented by the time horizon for which the analysis was carried out (2006-2022) and which includes the period of the Covid-19 pandemic during which, on the one hand, energy demand decreased, and on the other hand, there have been a number of delays in renewable energy projects. This time horizon chosen for the analysis includes a series of data that can distort the results.

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Appendix 1. Bayesian Network Analysis results by applying GGM

Summary of Network

Number of nodes	Number of non-zero edges	Sparsity
8	**9 / 28**	**0.679**

Table 1. Weights matrix

	Network							
Variable	**RE**	**EPI**	**KOF**	**GES**	**POV**	**EE**	**GDP**	**PD**
RE	0.000	0.000	0.169	-0.393	0.000	0.000	0.000	-0.463
EPI	0.000	0.000	0.000	0.000	0.000	0.098	0.279	0.000
KOF	0.169	0.000	0.000	0.000	0.000	0.000	0.929	0.098
GES	-0.393	0.000	0.000	0.000	0.000	0.000	0.163	0.000
POV	0.000	0.000	0.000	0.000	0.000	0.000	0.136	0.000
EE	0.000	0.098	0.000	0.000	0.000	0.000	0.000	0.000
GDP	0.000	0.279	0.929	0.163	0.136	0.000	0.000	0.000
PD	-0.463	0.000	0.098	0.000	0.000	0.000	0.000	0.000

Source: Authors' processing by JASP.

Table 2. Edge evidence probability table

Variable	RE	EPI	KOF	GES	POV	EE	GDP	PD
	Network							
RE	0.000	0.000	1.000	1.000	0.020	0.000	0.000	1.000
EPI	0.000	0.000	0.000	0.000	0.000	1.000	1.000	0.000
KOF	1.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000
GES	1.000	0.000	0.000	0.000	0.210	0.000	1.000	0.010
POV	0.020	0.000	0.000	0.210	0.000	0.000	1.000	0.000
EE	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000
GDP	0.000	1.000	1.000	1.000	1.000	0.000	0.000	0.000
PD	1.000	0.000	1.000	0.010	0.000	0.000	0.000	0.000

Source: Authors' processing by JASP.

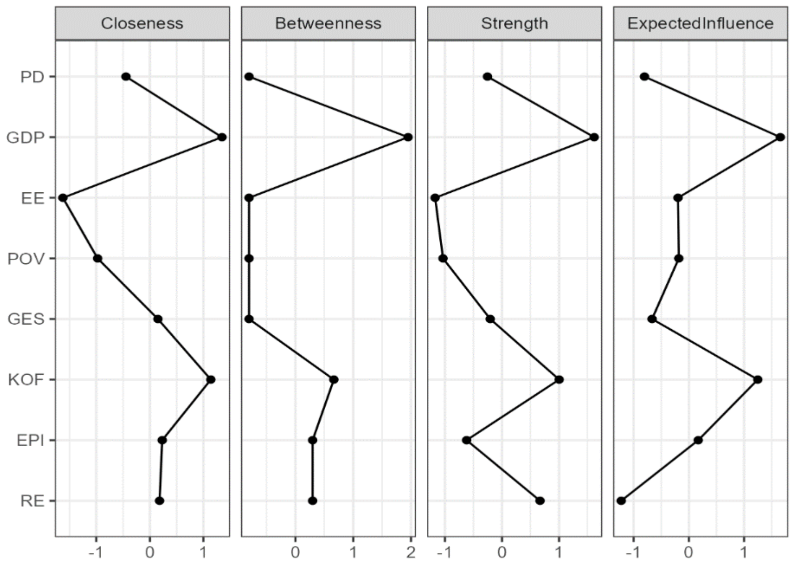

Figura 1. Centrality plot

Source: Authors' processing by JASP.

Table 3. Centrality measures per variable

Variable	Betweenness	Closeness	Strength	Expected influence
	Network			
RE	0.298	0.181	0.667	-1.226
EPI	0.298	0.231	-0.620	0.170
KOF	0.665	1.138	1.003	1.249
GES	-0.803	0.150	-0.206	-0.667
POV	-0.803	-0.975	-1.034	-0.183
EE	-0.803	-1.623	-1.172	-0.197
GDP	1.950	1.346	1.617	1.657
PD	-0.803	-0.446	-0.254	-0.804

Source: Authors' processing by JASP.

Appendix 2. Bayesian Network Analysis results by applying GcGM

Summary of Network

Number of nodes	Number of non-zero edges	Sparsity
8	14 / 28	0.500

Table 4. Weights matrix

	Network							
Variable	**RE**	**EPI**	**KOF**	**GES**	**POV**	**EE**	**GDP**	**PD**
RE	0.000	0.000	0.000	-0.333	0.000	0.152	0.000	-0.337
EPI	0.000	0.000	0.000	0.000	0.190	0.000	0.227	0.000
KOF	0.000	0.000	0.000	0.000	-0.320	0.579	0.658	0.075
GES	-0.333	0.000	0.000	0.000	0.000	0.000	0.226	0.167
POV	0.000	0.190	-0.320	0.000	0.000	0.233	0.000	-0.100
EE	0.152	0.000	0.579	0.000	0.233	0.000	-0.351	0.363
GDP	0.000	0.227	0.658	0.226	0.000	-0.351	0.000	0.000
PD	-0.337	0.000	0.075	0.167	-0.100	0.363	0.000	0.000

Source: Authors' processing by JASP.

Table 5. Edge evidence probability table

	Network							
Variable	**RE**	**EPI**	**KOF**	**GES**	**POV**	**EE**	**GDP**	**PD**
RE	0.000	0.090	0.260	1.000	0.080	0.780	0.180	1.000
EPI	0.090	0.000	0.310	0.070	0.880	0.050	0.950	0.050
KOF	0.260	0.310	0.000	0.090	0.950	1.000	1.000	0.540
GES	1.000	0.070	0.090	0.000	0.070	0.280	1.000	0.810
POV	0.080	0.880	0.950	0.070	0.000	0.900	0.210	0.560
EE	0.780	0.050	1.000	0.280	0.900	0.000	1.000	1.000
GDP	0.180	0.950	1.000	1.000	0.210	1.000	0.000	0.140
PD	1.000	0.050	0.540	0.810	0.560	1.000	0.140	0.000

Source: Authors' processing by JASP.

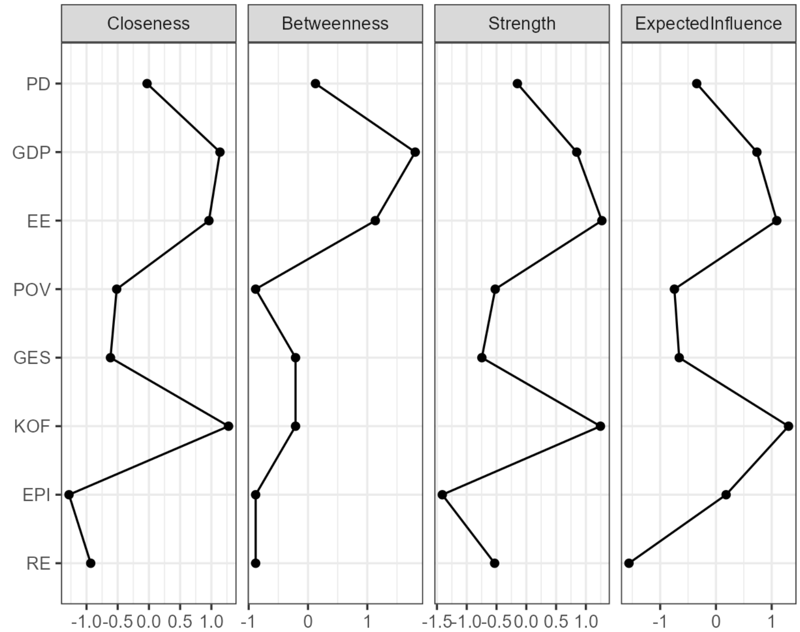

Figura 2. Centrality plot

Source: Authors' processing by JASP.

Table 6. Centrality measures per variable

	Network			
Variable	**Betweenness**	**Closeness**	**Strength**	**Expected influence**
RE	-0.883	-0.932	-0.532	-1.560
EPI	-0.883	-1.280	-1.410	0.182
KOF	-0.210	1.275	1.245	1.302
GES	-0.210	-0.616	-0.746	-0.659
POV	-0.883	-0.516	-0.522	-0.745
EE	1.135	0.961	1.269	1.091
GDP	1.808	1.138	0.846	0.735
PD	0.126	-0.030	-0.149	-0.345

Source: Authors' processing by JASP.