energies

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Ecological Footprint-Environmental Regulations Nexus: The Case of the Union for the Mediterranean

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Abstract: The environmental regulations–ecological footprint nexus is occupying an important space in the current debate of energy economics. As a counter measure to environmental degradation, implementing environmental regulations remains on the agenda of scholars and policymakers alike, but whether these regulations have a reducing impact on the ecological footprint remains open since the literature on the topic, and empirical evidence, remains fragmented and dissimilar. The current approach aimed to investigate this for five member countries of the Union for the Mediterranean with panel data econometric techniques. Panel data from France, Italy, Portugal, Spain, and Türkiye were considered for 1992–2015 and were tested for cross-sectional dependence, unit roots, and cointegration. Panel fixed effect regression estimations were conducted, also with Newey-West and Driscoll-Kraay standard errors. In addition, a country-level analysis was conducted by using fully modified ordinary least squares estimation. The results showed that energy consumption and trade increased the environmental footprint, but for environmental regulations, no conclusive effect was identified. The country-level analysis indicated that there is a divergent situation for environmental regulations among the five member countries, where only one out of five member countries showed a significant negative effect. This new empirical evidence for Union for the Mediterranean member countries highlights the importance of a common regulatory policy framework to combat the negative impacts of environmental degradation.

Keywords: environmental regulations; environment patents; ecological footprint; trade; energy consumption

Citation: Karşılı, H.; Erkut, B. Ecological Footprint-Environmental Regulations Nexus: The Case of the Union for the Mediterranean. *Energies* **2022**, *15*, 8493. https://doi.org/10.3390/en15228493

Academic Editor: John Boland

Received: 1 October 2022
Accepted: 9 November 2022
Published: 14 November 2022

1. Introduction

The current environmental degradation of the Mediterranean region is alarming, and attempts to preserve its environmental quality are far from being complete [1]. Recently, the Union for the Mediterranean (an intergovernmental organization consisting of 42 member states from the European Union and the Mediterranean basin) published a report to deliver the prediction that the Mediterranean region's average warming is expected to be 20% above the global average by the end of the 21st century [2]. The Mediterranean region has already exceeded the average temperature target of 1.5 degrees Celsius, and its energy demand is projected to increase by 40% in the next 18 years [1]. These numbers are problematic, and urgent action is necessary to combat these changes.

Despite the urge for action, there is also a problem with the Mediterranean region regarding climate governance, since this is based on complex arrangements with multiple actors acting in different ways to integrate climate change into the policy action agenda [3]. With the establishment of the Union for the Mediterranean, two signature projects were realized: The Mediterranean Solar Plan and the Depollution of the Mediterranean Project. Both projects aimed to contribute to climate change mitigation in multiple ways, but the Union for the Mediterranean also faced some criticism because of fragmented regional efforts towards mitigating climate change, a lack of financial commitments, and a narrow focus on renewable energies [3].

The aim of this work was to focus on five members of the Union for the Mediterranean to identify possible impacts on the ecological footprint. In this sense, this work aimed to go beyond the existing approaches to integrate environmental regulations as a possible source of influence that can bridge the gap between innovations and the ecological footprint. In addition, going beyond existing approaches, this work aimed to integrate recent panel data econometric techniques for data analysis. The rest of the paper is structured as follows: Part 2 presents a comprehensive literature review, summarizing important results from the extant literature. Part 3 presents the methodological toolkit of the work, whereas Part 4 presents the results of the analysis. Part 5 presents a discussion and concludes the work.

2. Literature Review

The ecological footprint is one of the footprints from the footprint family, going back to a broad definition of capturing human pressure on the environment [4]. Going back to the seminal work of Rees and Wackernagel [5], the concept was mainly brought forward as an alternative to the measurement of economic growth by means of the gross domestic product of a country. The definition evolved to include "human use of cropland, forests for timber, build-up land, grazing land, and fishing grounds on the consumption side, and a land needed to capture carbon dioxide on the waste absorption side" [4] (p. 3) and has been measured by the Global Footprint Network since then. The concept of the ecological footprint is a disputed measure. Some claim that, despite its simplicity and popularity, the concept still needs further elaboration [6], whereas others indicate that it is a "comprehensive indicator of environmental degradation" [7] (p. 2). To understand and elaborate this concept further, its relationship with energy use, trade, and environmental regulations needs to be elaborated.

Energy use is a necessity in many economic activities of industrialized countries, but it may have a deteriorating impact on the ecological footprint of a country. The previous literature indicates that energy use, especially fossil energy use, in economic activities increase the ecological footprint of a country, whereas renewable energy use can reduce it [7]. Ref. [8] indicates that the 1972 Meadow Report publication and the 1973 and 1979 oil shocks made many countries aware of the fragility of their growth model that is driven by the consumption of exhaustible natural resources. According to [8], it was the 1992 Rio Conference that made a significant shift in the so-called infinite growth model. The authors indicated that it was this turning point that made environmental policy stand on the same line as economic policy. Based on an exhaustive literature review, [9] indicated that energy use is expected to increase the ecological footprint.

Ref. [10] focused on the role of trade in increasing the ecological footprint in their work. According to the authors, once many countries reach a certain development level, it is only natural that their consumers ask for more and differentiated goods and services. Since international trade is the channel through which goods and services are being delivered to consumers across the world, an immediate consequence is the increase in the air and soil pollution [10]. A recent finding by [11] indicated that trade and GDP are proportional, whereas trade and distance between two countries are inversely proportional. As a matter of fact, recent empirical evidence by [12] also approved the degrading role of trade.

When we combine the effects of both trade activities and energy use, we notice that there is an urgent need to curb this combined effect on the environment. This can go through the implementation of stringent environmental regulations that can, on the one side, improve the environmental quality and, on the other side, lower the energy intensity levels [13]. A critical issue in this sense is the difference in the environmental regulations of different countries. The contribution of [14] pointed out the fact that carbon-intensive and energy-intensive industries relocate from countries with strict environmental regulations to countries with a weak environmental regulation, and this leads to the consequence that this relocation puts an obstacle in front of the realization of sustainable development goals. Ref. [15] also found out that strict environmental regulations reduce the environmental footprint and contribute to environmental quality. One should also mention that environmental regulations may not always end in the desired way. For instance, it is possible that they are implemented in an inefficient way, and, through that, their possible benefits are overshadowed by this inefficiency [15].

The past literature on the ecological footprint–environmental regulation nexus for the Union for the Mediterranean countries is limited. For instance, the recent contribution by [16] focused on Ethiopia and Egypt regarding the role of technological innovations (approximated by the number of patent applications) on the ecological footprint. The authors identified that the feedback hypothesis holds for the relation between technological innovations and the ecological footprint. The contribution by [13] focused on the next eleven countries to understand the impact of environmental regulations on the ecological footprint. The authors found that environmental regulations reduce the ecological footprint, but only in some of the next eleven countries. A more comprehensive data analysis of 35 countries, including some Union for the Mediterranean members, was conducted by [17]. The author found that the impact of environmental regulations (approximated by environmental patents) is positive, stating that "if patents in environmental technologies were to double as a share of all patents, we would expect to see an 18.2% increase" [17] (p. 236) in the ecological footprint. In contrast to these findings, the study by [18] investigated the group Organization for Economic Cooperation and Development countries, including some Union for the Mediterranean member countries to identify that environmental regulations decrease the ecological footprint. However, the impact was present only in the long run. For the short run, the author did not find any significant findings. Table 1 summarizes these empirical contributions that involve at least one member country of Union for the Mediterranean by means of country name, years, estimation strategy, and main findings.

Table 1. Selected empirical literature involving Union for the Mediterranean member countries.

Contribution	Member Country Involved (Years)	Estimation Strategy	Main Findings
[16]	Egypt (1980–2020)	Autoregressive distributed lag	Feedback hypothesis (technological innovation ⇔ ecological footprint)
[13]	Türkiye and Egypt (1990–2017)	Augmented mean group, fully modified ordinary least squares	Environmental regulations decrease ecological footprint only in some countries
[17]	Austria, Belgium, South Cyprus, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Morocco, Netherlands, Poland, Portugal, Spain, Sweden, Türkiye, United Kingdom (1982–2016)	Panel regression	Environmental regulations increase ecological footprint
[18]	Belgium, Denmark, France, Greece, Netherlands, Spain, Sweden, Türkiye, Italy, Finland (1990–2015)	Fixed effects, feasible generalized least squares, panel corrected standard errors, cross-sectional augmented autoregressive distributed lag	Environmental regulations decrease the ecological footprint (but only in the long run)

To sum up, the literature on the ecological footprint–environmental regulation nexus is largely fragmented and dissimilar. This dissimilarity can be because of the different path dependencies along industrialization, different economic and environmental policies, and the level of growth of economies. Despite this fact, the analyzed studies confirmed the deteriorating effect of energy use on the ecological footprint, but for the improving effect of environmental regulations on ecological footprint, there is no consensus. However, empirical evidence focusing only on the Union for the Mediterranean member countries regarding the environmental regulations–ecological footprint nexus remains to be a terra incognita.

3. Materials and Methods

3.1. Model

The model is captured by Equation (1):

$$\text{Ecological Footprint} = \beta_0 + \beta_1\text{Energy Use} + \beta_2\text{Trade} + \beta_3\text{Environmental Regulations} + \mu_{it} \quad (1)$$

For the equation above, β_0 is the intercept, whereas β_{1-3} are elasticity parameters that are going to be estimated using the fixed effect panel regression model with Driscoll-Kraay standard errors and Newey-West standard errors. i stands for country (with $i = 1, 2, 3, 4, 5$), t stands for time (with $t = 1, 2, \ldots, 24$), and μ_{it} stands for the error term. Country-level observations were utilized in the framework of a fully modified least squares estimation. All variables were considered in logarithmic terms.

3.2. Data

Even though the Union for the Mediterranean has been active since 2008 and regularly publishes technical reports, data availability for the member countries remains restricted. Annual data for five member countries (in alphabetical order: France, Italy, Portugal, Spain, Türkiye) were utilized for the period 1992–2015 since these are the countries for which the data availability did not provide any problems and gave a balanced panel. The dependent variable is the ecological footprint (global hectares per capita) and was taken from the website of the Global Footprint Network. The independent variables were trade, which was measured as the sum of total exports and imports as a proportion of the GDP; energy use, which was measured in kilograms of oil equivalent per capita; and environmental regulations, which was measured as patents on environment technologies. Data on trade and energy use were taken from the World Bank World Development Indicators Database, whereas data on environmental regulations were taken from the Organization of Economic Cooperation and Development database.

Table 2 provides an overview of the data. EF stands for ecological footprint, ER stands for environmental regulations, EU stands for energy use, and T stands for trade. From Table 2, one can notice that environmental regulations increased over time for all countries of observation, and energy use roughly remained the same for France and Italy, whereas it increased for Portugal, Spain, and Türkiye. Trade, on the other hand, increased dramatically for all countries of observations. Last, but not least, ecological footprint dropped for all countries of observation except Türkiye. Data are visualized in Figures 1–5 for France, Italy, Portugal, Spain, and Türkiye, respectively.

Table 2. Country-level data.

Year	1992				2002				2015			
	EF	**ER**	**EU**	**T**	**EF**	**ER**	**EU**	**T**	**EF**	**ER**	**EU**	**T**
France	5.584	7.09	3954	41.992	5.512	6.79	4225.47	53.072	4.70	13.40	3692.02	61.752
Italy	5.191	5.37	2627.34	34.914	5.515	6.28	3037.27	48.058	4.28	10.66	2481.75	56.418
Portugal	4.355	5.82	1813.89	56.307	4.715	12.61	2447.79	62.308	4.00	12.28	2131.68	80.491
Spain	4.701	5.61	2430.37	35.978	5.566	4.8	3107.87	55.099	3.93	13.62	2571.34	64.213
Türkiye	2.389	6.90	961.931	31.737	2.69	8.15	1139.35	47.98	3.26	9.67	1651.36	51.089

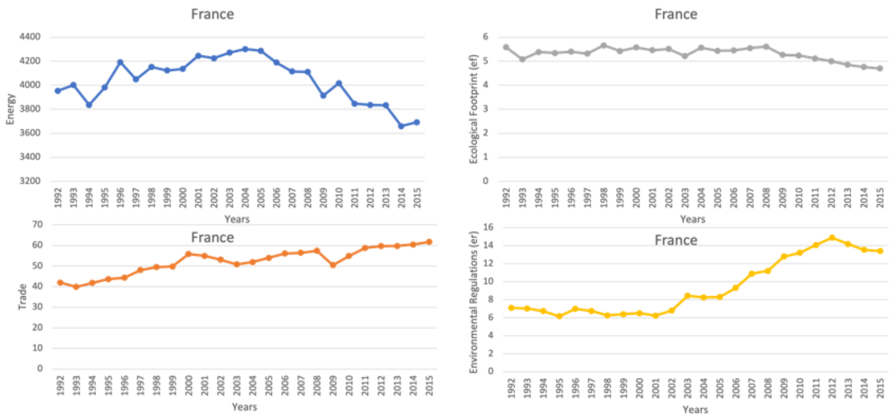

Figure 1. Data visualization for France.

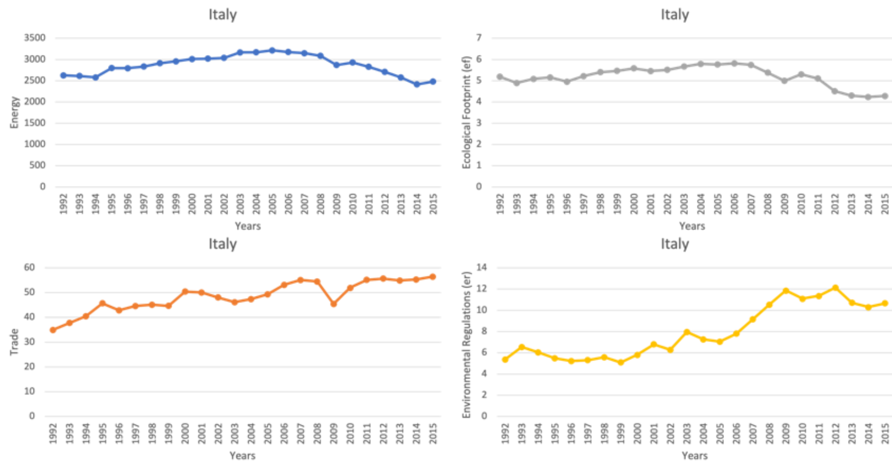

Figure 2. Data visualization for Italy.

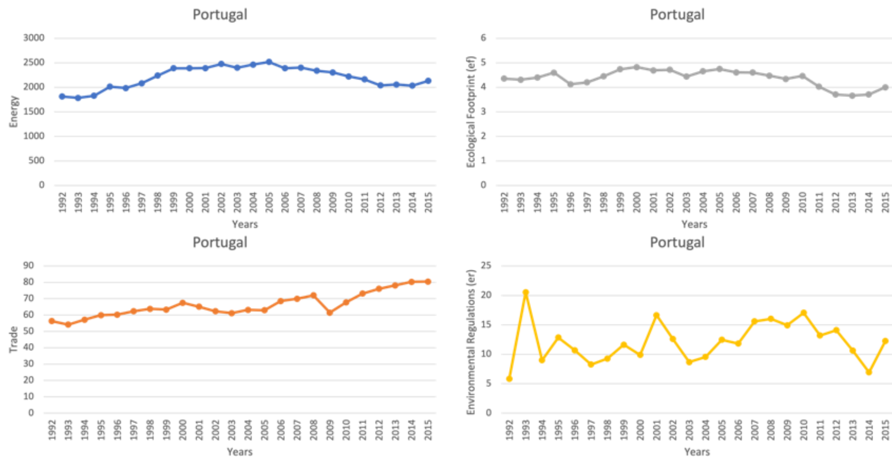

Figure 3. Data visualization for Portugal.

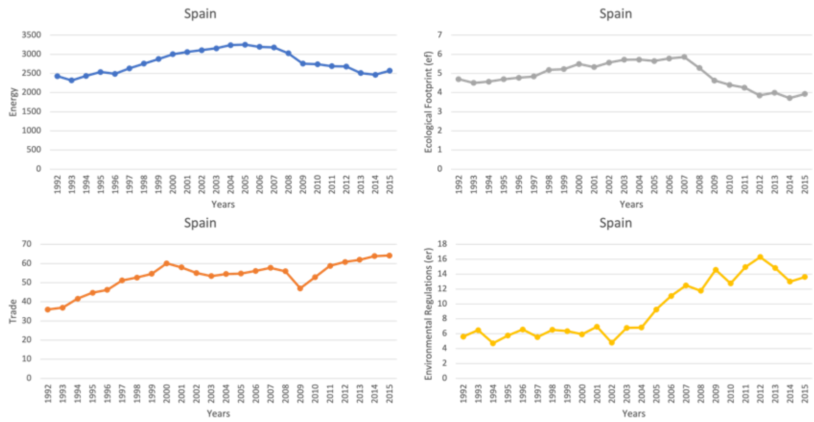

Figure 4. Data visualization for Spain.

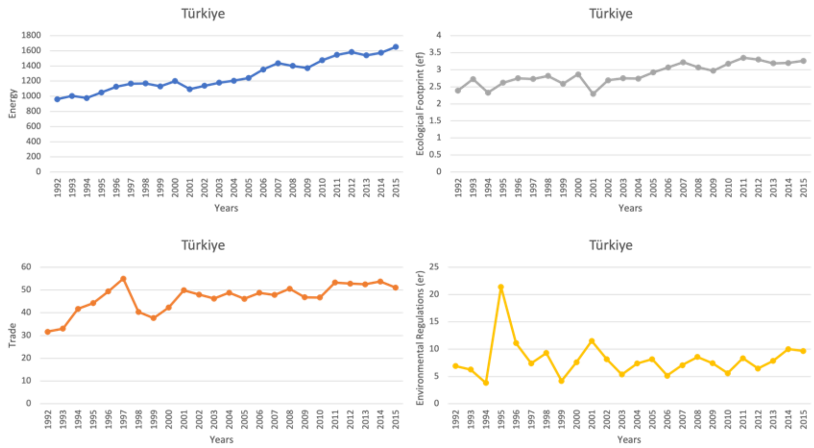

Figure 5. Data visualization for Türkiye.

3.3. Cross-Sectional Dependence

Controlling for cross-sectional dependence in panel data is necessary since their presence may lead to biased estimations in case of panel fixed effect regressions. Since the number of cross-sections (countries) is smaller than the number of periods (years) in data, the Pesaran cross-sectional dependence test in the sense of [19] was utilized for this purpose. The test statistics are given as:

$$\mathrm{CD} = \sqrt{\frac{2\mathrm{T}}{\mathrm{N}(\mathrm{N}-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N-1}\rho_{ij}\right)\mathrm{N}(0,1) \tag{2}$$

In Equation (2), T stands for time, N stands for cross-sections, and ρ_{ij} stands for the correlations of error between i and j in cross-sections. In addition, Breusch-Pagan LM and Pesaran scaled LM tests were also utilized for confirming the results of the Pesaran cross-sectional dependence test.

3.4. Unit Root

This research utilized the Cross-sectional Augmented Dickey-Fuller Test (CADF) in the sense of [20], which is given in Equation (3):

$$\Delta y_{it} = a_i + b_i y_{i,t-1} + c_i \overline{y}_{t-1} + \sum_{j=0}^{s} d_{ij}\Delta\overline{y}_{t-j} + \sum_{j=1}^{s} \delta_{ij}\Delta\overline{y}_{i,t-j} + e_{it} \tag{3}$$

Considering Equation (3), $\overline{y}$ stands for the averages of the cross-sectional dependent variables at lagged levels, whereas $\Delta\overline{y}$ stands for the averages of the cross-sectional dependent variables at first differences.

3.5. Cointegration

The Pedroni cointegration test [21] was utilized in this research to understand whether the variables of interest were cointegrated. In this sense, the Pedroni cointegration test's point of departure is Equation (4):

$$y_{it} = a_i + b_i t + c_{1i} x_{1i,t} + c_{2i} x_{2i,t} + \cdots + c_{Hi} x_{Hi,t} + e_{it} \quad (4)$$

In Equation (4), t stands for time, i stands for cross-sections, H stands for the number of independent variables, a_i stands for the cross-section-specific intercept, c_{1i-Hi} stand for the slope coefficients, and e_{it} stands for the residual. The null hypothesis (no cointegration) for the Pedroni cointegration test indicates that e_{it} is I(1).

For understanding whether e_{it} is I(1), the following equation was estimated for each cross-section:

$$e_{it} = \rho_i e_{i,t-1} + \mu_{it} \quad (5)$$

For performing the Pedroni cointegration test, two separate models were considered as within-dimension and between-dimension, with the use of the following test statistics:

$$T\sqrt{NZ_{\hat{\rho}N,T-1}} \equiv T\sqrt{N}\left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}e_{i,t-1}^{2}\right)^{-1}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\left(\hat{e}_{i,t-1}\Delta\hat{e}_{it} - \frac{1}{2}\left[\hat{\sigma}_i^2 - \hat{s}_i^2\right]\right) \quad (6)$$

$$Z_{tN,T}^{*} \equiv \left(\frac{1}{N}\sum_{i}^{N}s_i^{*2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}e_{i,t-1}^{2}\right)^{-\frac{1}{2}}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}e_{i,t-1}\Delta\hat{e}_{it} \quad (7)$$

$$TN^{-\frac{1}{2}}Z_{\hat{\rho}N,T-1} \equiv TN^{-\frac{1}{2}}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}\hat{e}_{i,t-1}^{2}\right)^{-1}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\left(\hat{e}_{i,t-1}\Delta\hat{e}_{it} - \frac{1}{2}\left[\hat{\sigma}_i^2 - \hat{s}_i^2\right]\right) \quad (8)$$

$$N^{-\frac{1}{2}}Z_{tN,T}^{*} \equiv N^{-\frac{1}{2}}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}\frac{1}{N}\sum_{i}^{N}s_i^{*2}\hat{e}_{i,t-1}^{2}\right)^{-\frac{1}{2}}\sum_{t=1}^{T}\hat{e}_{i,t-1}\Delta\hat{e}_{it} \quad (9)$$

Considering the above-illustrated equations, Equation (6) stands for the panel-ρ statistic, Equation (7) stands for the panel-t statistic, Equation (8) stands for the group-ρ statistic, and Equation (9) stands for the group-t statistic.

3.6. Parameter Estimations and Causality

The elasticity parameters β_{1-3} of Equation (1) were estimated using fixed effect panel data regression, but for the sake of completeness, a random effect panel data regression model was also estimated to compare the consistency of the two models using the Hausman test. The panel data regression model that obtained a green light from the Hausman test is presented with Driscoll-Kraay standard errors (DK) in the sense of [22] and Newey-West standard errors (NW) in the sense of [23]. DK standard errors account for the cross-sectional dependence of panel data and, as such, deliver standard errors that are estimated in a robust and consistent way. NW standard errors were used for confirming the results and noticing their robustness. In addition, country-level estimations were conducted using the fully modified ordinary least squares (FMOLS) estimation, which can give an overview of the long-run relationship among the observed variables [24]. Last, but not least, a causality analysis was performed using the contribution by [25].

4. Results

The results are presented as follows. The empirical estimation strategy starts with the detection of cross-sectional dependence and continues with tests of the unit root and cointegration before the main results of the analysis are presented by means of parameter estimations in the tradition of the fixed effect panel regression model with DK standard errors and NW standard errors, a country-level overview of the estimations using the fully modified least squares estimation, and a causality test in the tradition of Dumitrescu-Hurlin.

4.1. Cross-Sectional Dependence

Table 3 presents the results of the cross-sectional dependence tests in the sense of Pesaran CD, Breusch-Pagan LM, and Pesaran Scaled LM. All test results were highly significant, rejecting the null hypothesis of cross-sectional independence. The results justified the choice of DK standard errors when performing the fixed effect panel regression. The results were expected because of the common issues of these countries—four of the observed countries are members of the European Union, one of them is a candidate country, which is, nevertheless, a part of the Customs Union. All five countries signed the Paris Agreement. This common ground highlights that these countries follow similar environmental rules and regulations due to the implications of the EU membership or harmonization processes and the Paris Agreement.

Table 3. Cross-sectional dependence test results. Variables are in logarithmic terms.

Variable	Pesaran CD	Breusch-Pagan LM	Pesaran Scaled LM
Ecological footprint	5.408 ***	126.06 ***	25.961 ***
Environmental regulations	5.771 ***	71.593 ***	13.773 ***
Energy use	7.287 ***	105.44 ***	21.342 ***
Trade	13.064 ***	172.92 ***	36.43 ***

*** implies statistical significance at 1% level.

4.2. Unit Root

Table 4 presents the results of the panel unit root tests in the sense of CADF. The results highlight that all variables were stationary in their first differences, leading to the possibility of co-integration.

Table 4. Panel unit root test results. Variables are in logarithmic terms.

Variable	CADF	
	I(0)	I(1)
Ecological footprint	−1.969	−6.880 ***
Environmental regulations	−3.859 **	−12.536 ***
Energy use	−2.312	−5.690 ***
Trade	−4.617 ***	−9.641 ***

*** implies statistical significance at 1% level, ** implies statistical significance at 5% level.

4.3. Cointegration

Table 5 presents the results of the Pedroni panel cointegration test. According to the results, 7 out of 7 test statistics rejected the null hypothesis of no cointegration between the variables for the case with intercept, whereas 5 out of 7 test statistics rejected the null hypothesis for the case with intercept and trend. The results therefore indicated that there is a long-term relationship among the variables.

Table 5. Pedroni panel cointegration test results.

Dimension	Test Statistics	Intercept	Intercept and Trend
Within-dimension	Panel-v statistic	1.532 *	0.910
	Panel-rho statistic	−2.431 ***	−1.624 *
	Panel-P statistic	−4.493 ***	−4.770 ***
	Panel-ADF statistic	−4.429 ***	−3.914 ***
Between-dimension	Group-rho statistic	−1.899 **	−0.929
	Group-PP statistic	−5.311 ***	−4.949 ***
	Group-ADF statistic	−5.378 ***	−2.627 ***

*** implies statistical significance at 1% level, ** implies statistical significance at 5% level, * implies statistical significance at 10% level.

4.4. Parameter Estimations

Table 6 presents the results of the estimations using the fixed effect panel regression approach with DK standard errors and NW standard errors. To decide for the choice of the model, a Hausman test was conducted to understand whether a fixed effect model or a random effect model should be used in the first place, which resulted in a chi-squared test statistic of 26.421 with 3 degrees of freedom and a p-value of 0.000, giving a green light for a fixed effect estimation (two-way fixed effects). According to the fixed effect estimation results, it was confirmed that energy use and trade both increase ecological footprint. The corresponding coefficients were statistically significant. The Driscoll-Kraay and Newey-West approaches also confirmed this. This finding confirmed the findings of [9,26,27], who all identified similar findings in different contexts. On the other hand, environmental regulations did not have any statistically significant impact on ecological footprint. This is in line with the findings of [28], who found that environmental regulations in the Middle East-North Africa region are not yet in their desired state. Similarly, [29] also founds that there is no clear evidence of environmental regulations reducing levels of pollution for the European Union countries. This can be seen as a contradiction to the findings of [17], who identified that environmental regulations actually increase ecological footprint.

Table 6. Estimations using FE and DK. Independent variables are in logarithmic terms. T-statistics are in parentheses. Dependent variable is ecological footprint in logarithmic terms.

Variable	FE	FE s.e.	DK	DK s.e.	NW	NW s.e.
Environmental regulations	0.007 (0.388)	0.017	0.007 (0.489)	0.014	0.007 (0.441)	0.015
Energy use	0.849 (16.056) ***	0.053	0.849 (16.327) ***	0.052	0.849 (17.569) ***	0.048
Trade	0.142 (1.786) *	0.080	0.142 (2.983) **	0.048	0.142 (1.960) *	0.073
R-squared	0.761					
Adjusted R-squared	0.680					
F-statistic	94.352 ***					

*** implies statistical significance at 1% level, ** implies statistical significance at 5% level, * implies statistical significance at 10% level.

Table 7 presents the results of the country-level estimations using fully modified ordinary least squares regression. Accordingly, for France only, energy use appeared to have a statistically significant impact on ecological footprint. The sign of the coefficient was positive. For Italy, Portugal, and Türkiye, energy use and trade had statistically significant impacts on ecological footprint, whereas energy use increased ecological footprints for all three countries, trade increased ecological footprint only for Italy, and it decreased ecological footprint for Portugal and Türkiye. Finally, all three variables were identified to have statistically significant impacts on ecological footprint for Spain only. In the case of Spain, trade and environmental regulations decreased ecological footprint, whereas energy use increased it.

Table 7. Country-level estimations using FMOLS analysis. Independent variables are in logarithmic terms. T-statistics are in parentheses. Dependent variable is ecological footprint in logarithmic terms.

Variable	France	Italy	Portugal	Spain	Türkiye
Environmental regulations	−0.019 (−0.488)	−0.037 (−1.720)	0.033 (1.192)	−0.101 (−3.443) ***	0.012 (0.564)
Energy use	0.837 (4.167) ***	1.073 (19.796) ***	0.573 (7.649) ***	1.264 (11.713) ***	0.667 (11.056) ***
Trade	−0.076 (−0.872)	0.056 (−3.026) ***	−0.512 (−7.453) ***	−0.336 (−3.471) ***	−0.167 (−2.066) *
R-squared	0.660	0.928	0.789	0.927	0.855
Adjusted R-squared	0.606	0.916	0.755	0.915	0.832

*** implies statistical significance at 1% level, * implies statistical significance at 10% level.

4.5. Causality

Table 8 presents the results of the Dumitrescu-Hurlin Causality Test. The results show that there are bidirectional causality relations between ecological footprint and energy, ecological footprint and environmental regulations, as well as ecological footprint and trade. In addition, trade drives energy consumption, and there is a bidirectional causality relationship between energy consumption and environmental regulations.

Table 8. Dumitrescu-Hurlin Causality Test results.

Null Hypothesis	Wbar	Zbar	*p*-Value	Conclusion
EF → ER	5.110	6.498	0.000	
ER → EF	3.171	3.433	0.001	Bidirectional causality (1% level)
EF → Energy	4.271	5.171	0.000	
Energy → EF	3.475	3.913	0.000	Bidirectional causality (1% level)
EF → Trade	2.545	2.443	0.015	
Trade → EF	2.354	2.140	0.032	Bidirectional causality (5% level)
Trade → Energy	1.11	0.176	0.861	
Energy → Trade	2.164	1.841	0.066	Unidirectional causality Trade → Energy (10% level)
ER → Energy	2.323	2.091	0.037	
Energy → ER	6.475	8.657	0.000	Bidirectional causality (5% level)

Regarding the bidirectional causality between ecological footprint and environmental regulations, the results of [16] were confirmed, and the results of [13] were contradicted. Regarding the bidirectional causality between ecological footprint and energy use, and the unidirectional causality between trade and energy use, the results of [13] were confirmed. The case of a bidirectional causality between trade and ecological footprint contradicts the findings of [13].

5. Discussion and Conclusions

The last couple of decades saw a number of high-level policies aiming to decouple economic growth from environmental degradation and a movement towards the implementation of strict environmental regulations [30]. Despite this fact, one cannot talk about a world-wide convergence as the implementation of these high-level policies proceeded in different speeds and with different social, economic, legislative, and political conditions. A region that rings alarm bells in this dispute is the Mediterranean region, since its energy demand is expected to increase by 62% in the next 18 years, but the region has already exceeded the average temperature of 1.5 degrees Celsius as proposed by the Paris Agreement [31].

Despite this urgency, there is still no formal or legislative coordination among the Union for the Mediterranean Countries, even though the problem was identified earlier and some steps have been taken. For instance, the recently published 2021 annual report of the Union for the Mediterranean places an important weight on the topics of the environment and climate action [32]. It was reported that the member states of the Union for the Mediterranean met on 4 October 2021 to agree upon an agenda called "Towards 2030: Agenda for a Greener Med—Contributing to the Achieving the Environmental SDGs in the Mediterranean", which is a declaration to mitigate climate change and its consequences [33]. In this declaration, the member states of the Union for the Mediterranean declared that innovative solutions are required to mitigate climate change and its consequences, which, on the one hand, requires technological innovations and, because of them, investment in research and development, and on the other hand, a social context that welcomes these innovations, coupling needs with technology. An emphasis was made regarding energy transition, and the Union for the Mediterranean Energy Platforms was established, which provides a channel for dialogue between the member countries [32]. These steps show that the problem is taken seriously, but action needs to be taken that can transfer ideas and declarations into policies and standards.

In line with the results, it is obvious that one member country in the sample could successfully implement environmental regulations that could decrease the ecological footprint (Spain), but for the other member countries, as well as the overall sample of five member countries, no significant effect was detected. As shown by [1], more effort needs to be put on the effective development of environmental technologies that can reduce the ecological footprint of countries; however, the results indicate that this may not be the entire picture, as environmental regulations accompanied by environmentally friendly technologies need to be implemented in an efficient way to observe the desired outcome. Currently, despite many efforts, the sample from the Union for the Mediterranean is far from this situation. Results of this research call for a common framework of environmental regulations that can reduce the ecological footprint of the Union for the Mediterranean member countries. This is not an easy issue, as empirical evidence sometimes shows a contradictory effect of environmental technologies, increasing the ecological footprint [17]. This picture indicates a twofold approach to make progress: firstly, to establish research and to develop infrastructures that can encourage and support the development of environmental technologies in the Union for the Mediterranean member countries; and secondly, to ensure that these environmental technologies do not create an undesired effect of increasing the ecological footprint. For the researchers, it remains to focus on the country-level analysis of possible scenarios of convergence for the future, also by an improved data quality from other member countries.

Author Contributions: Conceptualization, H.K.; methodology, B.E.; software, B.E.; formal analysis, B.E.; writing—original draft preparation, B.E.; writing—review and editing, H.K.; data visualization, H.K. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: Data used in this study were taken from World Bank World Development Indicators, Organization of Economic Cooperation and Development database, and Global Footprint Network database.

Acknowledgments: The authors would like to express their gratitude to two anonymous referees and the editor for constructive comments, suggestions, and feedback.

Conflicts of Interest: The authors declare no conflict of interest.

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