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Nonlinearities in Economic Globalization Effects on the Environment: New Insights from a Panel Smooth Transition Regression Model *

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Abstract

This study aimed to estimate the impact of economic globalization on environmental quality and examine the role of renewable energy production (REP) in this impact. For this purpose, the annual data of 1976–2021, which is the longest possible period, of the top 5 countries (Sweden, Switzerland, Norway, France, and Denmark) that show the best performance according to the Global Green Economy Index 2022 report, were used. These countries were chosen due to their high performance in green economy integration; and thus, it was considered that this research could provide reference results for other countries. In order to achieve this, the panel smooth transition regression model was applied to the dataset. This nonlinear approach divides the series into homogeneous regimes depending on the threshold variable and allows us to make regime-specific interpretations. As a result, this study, in which REP was defined as the threshold variable, has shown that there is a two-regime nonlinear relationship between environmental quality and economic globalization. According to the findings, economic globalization caused an increase in environmental degradation in the first regime, which had low REP. However, this impact was eliminated in the second regime, where REP was high.

Keywords:* *Renewable Energy Production, Ecological Footprint, Globalization, Panel Smooth Transition Regression Model, Threshold Values.

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1. INTRODUCTION

The notion of globalization is the result of the industrial development, technological progress, political transformations, and cultural changes of the modern world. While industrialization and technological progress have formed the basis for the economic interaction of countries, they have also resulted in a process of international dependency. This process affects social and political areas as well as economic areas. In this respect, the effects of globalization on the environment are one of the important points to be emphasized in the fight against climate change. Processes such as increasing foreign trade (import and export), foreign direct investments, and the development of tourism within the context of globalization have the potential to affect the ecosystems of the planet we live on as well as the economies of countries.

The world economy is becoming increasingly integrated. According to the World Trade Organization, world trade increased by 45 times from 1950 to 2022. There is a common view that it is not a coincidence that environmental problems are becoming more serious today at the same time as the increase in the pace of economic globalization. This view assumes that trade leads to economic growth, and growth leads to environmental degradation, so trade is bad for the environment (Copeland, 2009). It is also commonly thought that economic globalization is a force that pressures environmental regulation. However, this argument misses the fact that environmental quality is not the only goal for societies. People in the modern world are concerned about their income levels as much as the quality of the environment they live in, and trade is an important factor in promoting economic growth. If policymakers implement measures that could prevent economic growth based on environmental concerns, the economy would shrink. In this case, the concern for environmental quality would lose its priority. Therefore, balancing these two targets against each other is quite important (Frankel, 2003). This has caused much debate in policy circles and encouraged a high number of academic research studies. Following this motivation, this study investigated the impact of economic globalization on the environment and the role of renewable energy production (REP) in this impact.

To contribute to the literature, the top five countries with the best performance according to the Global Green Economy Index (GGEI) 2022 Report were analyzed. Thus, it is thought that the results to be obtained could be a reference for other countries. In addition, the panel smooth transition regression (PSTR) model allowed us to make regime-specific interpretations by separating the series into regimes depending on the threshold variable. Knowing this threshold value that separates regimes from each other would be a guide for developing preventive or incentive policies for countries that have not yet reached the threshold.

The structure of the paper was organized as follows: Section 2 provides the relevant literature, detailed information on the dataset and methodology is given in Section 3, empirical findings are presented in Section 4, and Section 5 contains the conclusions.

2. LITERATURE REVIEW

As a result of studies revealing the economic benefits of globalization, its effects on the environment have also become a subject of interest for researchers. In the last decade, the number of studies examining the relationship between the globalization and environmental performance has been increasing and expanding the related literature. Some of these studies have argued that globalization is beneficial for environmental protection (Leitão, 2014; Shahbaz et al., 2016; Shahbaz et al., 2020; Wang et al., 2021; Çetin et al., 2023), while others, on the contrary, claim that it causes environmental degradation (Leitão, 2013; Leitão & Shahbaz, 2013; Shahbaz et al., 2017; Sharif et al., 2019; Sultana et al., 2023). Among these studies, Leitão (2013) was the first to consider the globalization index as an explanatory variable. In a study covering the period between 1980–2010, the effects of economic growth, energy consumption, and the globalization index on carbon dioxide (CO_2) emissions were examined for Portugal, Spain, Greece, and Ireland. The empirical findings of the study emphasized that globalization intensively increases production by using local resources efficiently, thus increasing CO_2 emissions. However, as the literature expanded, more complex dynamics emerged. For instance, Pata (2021) analyzed the relationship between globalization and environmental pollution for Brazil, Russia, India, and China, (BRIC) spanning from 1971 to 2016, including renewable energy production. As a result, he emphasized that globalization has a negative impact on environmental performance in some countries but that this impact can be eliminated by renewable energy production. On the other hand, Ehigiamusoe et al. (2023) studied the interaction between globalization and tourism. In their research consisting of data for 31 selected African countries from 1995 to 2019, they applied a number of panel data tests to measure the impact of this interaction on CO_2 emissions. Contrary to Pata (2021), their empirical findings suggested that globalization reduces emissions.

As the relevant literature has expanded, the effects of globalization on the environment, taking into account its economic, social, and political dimensions, have emerged as a research issue. One of the early studies in this field for the case of Türkiye was conducted by Destek and Özsoy (2015). They examined the relationship between economic globalization, which is a sub-component of the globalization index, and emissions using annual data from 1970 to 2010. As a result, they asserted that economic integration in Türkiye reduces environmental pollution both in the long and short run. Similarly, Lv and Xu (2018) claimed that economic globalization has had a beneficial effect on environmental recovery in both the short and long run for 15 selected developing countries from 1970–2012. In addition, Lu et al. (2024) and Ximei et al. (2024) used the cross-sectional ARDL method and further supported these findings by showing that economic globalization contributed to environmental sustainability in BRICS-T and APEC countries, respectively.

In contrast to these findings, Phong (2019) conducted a study on five selected Asian countries spanning from 1971 to 2014 and concluded that globalization increases emissions and moreover, economic globalization is the major factor. Xu et al. (2018) enriched the literature in this field by including economic, social, and political globalization, as well as general globalization. They found that social, political, and general globalization did not cause environmental degradation, but economic globalization increased emissions in Saudi Arabia between 1971 and 2016. Farooq et al. (2022) supported these findings with their results obtained for a large panel of 180 countries using the panel quantile regression method. Destek (2020) aimed to examine the impact of globalization with its sub-components and investigated 12 selected Central and Eastern European countries from 1995 to 2015. In the empirical findings of the study, it was concluded that general and economic globalization caused environmental degradation, political globalization reduced pollution, and social globalization had no significant effect on the environment. Suki et al. (2020) used annual data from 1970 to 2018 for Malaysia with the same purpose. They found that in the long run, general and economic globalization increased the level of environmental degradation, while political and social globalization decreased it.

Recent studies have increasingly focused on alternative environmental metrics, such as the ecological footprint. Figge et al. (2016) were the first to consider the ecological footprint as an explained variable. Their study covered 183 countries and showed that globalization significantly increased pressure on the ecological footprint across these countries, while Ahmed et al. (2019) found that globalization did not significantly affect Malaysia's ecological footprint, but it increased its ecological carbon footprint. Moreover, Bilgili et al. (2019) found that economic and social globalization exacerbated the ecological footprint in Türkiye using nonlinear Markov regime switching models. Similarly, in their study, which included the data of 146 countries from 1981 to 2009, Rudolph and Figge (2017) found that economic globalization increased the ecological footprint, while social globalization decreased it.

More recently, Karaduman (2022) suggested that economic globalization could enhance environmental protection through reducing the ecological footprint across Next Eleven (N-11) countries, a finding echoed by Okere et al. (2022) for the North African region and by Villanthenkodath and Pal (2023) for India. Contrary to this result, Ahmad et al. (2022) and Bekun and Ozturk (2024) concluded that economic globalization increased the ecological footprint in E7 countries. These studies highlight that economic globalization can harm environmental sustainability and thus pointed out the necessity of implementing sustainable development policies.

Overall, the literature revealed a complex and often detrimental relationship between economic globalization and environmental sustainability. While economic globalization drives growth by integrating markets and enhancing trade, it frequently leads to environmental degradation through increased industrial activity and resource consumption. Several studies, such as those by Bilgili et al. (2019) and Ahmad et al. (2022), demonstrated that economic globalization contributes to the increase of the ecological footprint, particularly in developing economies. Moreover, economic globalization's focus on production and consumption often exacerbates CO_2 emissions, as highlighted by Leitão (2013) and Shahbaz et al. (2017). However, some recent research, including that by Pata (2021) and Çetin et al. (2023), suggested that the negative environmental impact of economic globalization can be mitigated through the adoption of renewable energy. This points to the need for balancing economic integration with sustainable energy practices to counteract the adverse environmental effects of globalization.

3. METHODOLOGY AND DATA

This study investigated how the increase in the level of economic globalization of countries affects their environmental performance and the role of REP in this effect using the PSTR model. In order to provide guidance for other countries, the top 5 countries (Sweden, Switzerland, Norway, France, and Denmark), which have shown the best performance according to the GGEI 2022 report, were included in the research. In addition, the largest possible data set, annual data from 1976 to 2021, was used. Accordingly, the Swiss Economic Research Institute (KOF) economic globalization index (EGI), developed by Dreher (2006) and revised by Gygli et al. (2019), was used to represent the economic globalization levels of the countries.

At the same time, ecological footprint per capita (EF) data were used to represent the environmental performance of the countries. The REP was determined as the transition variable, and the research question was aimed at being answered in the context of the REP. Ecological footprint data were provided by the Global Footprint Network (GFN), and globalization index data were taken from the KOF Globalization Index database. REP data were obtained from the International Energy Agency (IEA).

Table 1. Descriptive Statistics

Variables	Unit	Obs.	Mean	Std. Dev.	Min.	Max.
EF	Global hectares (Gha), per capita	230	6.4945	1.4297	3.7216	9.8222
EGI	Index (from 0 to 100)	230	73.6380	8.5482	50.5851	86.5416
REP	Petajoules (PJ)	230	423.4637	275.0293	16.6704	1149.043

Source: Authors' estimation.

Descriptive statistics prior to the empirical analysis are shown in Table 1. A look at the EF values shows that the lowest value for the whole panel was 3.7216, and the highest was 9.8222, with a mean of approximately 6.5 Gha. In terms of the EGI values, the index data varied between 50.5851 and 86.5416 with a mean value of 73.6380. Finally, REP had a mean of 423.5 PJ with a minimum of 16.7 PJ and a maximum of 1149 PJ.

The PSTR model developed by Gonzalez et al. (2005) was applied to the dataset. This method is a generalized form of the Panel Threshold Regression (PTR) model introduced by Hansen (1999).

These nonlinear methods separate the observations in the panel into homogeneous regimes depending on the value of another observable variable (the threshold variable). In other words, there is a transition between regimes. Therefore, regression coefficients may take different values in different regimes. Moreover, if the threshold variable changes over time, individuals are not restricted to remaining in the same regime in all time periods. However, while both models have these features, unlike the PTR model, the PSTR model allows for a smoother transition between regimes. This makes it more feasible than the PTR model for modeling many economic theories (Gonzalez et al., 2005).

The general PSTR model with two regimes can be defined as follows:

$$y_{it} = \mu_i + \beta_0' x_{it} + \beta_1' x_{it} g(q_{it};\gamma,c) + u_{it} \qquad i=1,\ldots,N \qquad t=1,\ldots,T \tag{1}$$

Here, y_{it} is the dependent variable, x_{it} is the independent variable, μ_i is the fixed individual effect, and u_{it} is the error. The transition function $g(q_{it};\gamma,c)$ is a continuous function of the threshold variable q_{it} and only takes a value between 0 and 1. Based on this equation, the following model was constructed to measure the impact of the level of economic globalization (EGI) on environmental performance (EF):

$$EF_{it} = \mu_i + \beta_0 EGI_{it} + \beta_1 EGI_{it} g(q_{it};\gamma,c) + u_{it} \tag{2}$$

Gonzalez et al. (2005) defined the transition function $g(q_{it};\gamma,c)$ in the logistic function form as follows:

$$g(q_{it};\gamma,c) = \frac{1}{1+\exp[-\gamma(q_{it}-c)]}, \qquad \gamma > 0 \tag{3}$$

Here, q_{it} is the natural logarithm of REP (lnREP) used as the threshold variable, c denotes the location (threshold) parameter, and γ is the slope (smoothing) parameter of the transition function. If γ tends to infinity $(\gamma \to \infty)$, the transition function $g(q_{it};\gamma,c)$ becomes an indicator function that takes the value 1 when $q_{it} > c$ and 0 otherwise. In this case, the transition from one regime to another is very sharp, as in the PTR model. Thus, the model can be estimated using the PTR method. If γ tends to zero, the $(\gamma \to 0)$ transition function $g(q_{it};\gamma,c)$ equals a constant. In this case, the model is collapsed into the standard linear model that includes cross-sectional effects.

The value of the transition variable (q_{it}) determines the value of the transition function $g(q_{it};\gamma,c)$, and therefore, the regression coefficients for individual i at time t may be shown as $\beta_0 x_{it} + \beta_1 x_{it} g(q_{it};\gamma,c)$. If the transition function takes the value 0, the regression coefficients are equal to β_0, and if it takes the value 1, the regression coefficients are equal to $\beta_0 + \beta_1$. When the transition function takes a value between 0 and 1, the regression parameter is the weighted average of β_0 and β_1

estimates. Therefore, in the PSTR model, instead of directly interpreting the parameter estimates, it is preferable to interpret the sign of the parameters and say that the effect of the independent variable on the dependent variable is positive or negative. In addition, time-varying elasticities for each horizontal cross-section can also be interpreted.

The PSTR model can also be multiple regime, i.e. with more than two regimes. In this case, the PSTR model can be generalized as follows:

$$y_{it} = \mu_i + \beta_0' x_{it} + \sum_{j=1}^{r} \beta_j' x_{it} g_j(q_{it}^{(j)}; \gamma_j, c_j) + u_{it} \tag{4}$$

The transition function in the multiple regime PSTR model is also as follows:

$$g(q_{it};\gamma,c) = \left(1+\exp\left(-\gamma\prod_{j=1}^{m}\left(q_{it}-c_j\right)\right)\right)^{-1}, \quad \gamma>0, \quad c_1 \le c_2 \le \ldots \le c_m \tag{5}$$

In this function, $c = (c_1,...,c_m)$ is the m-dimensional vector of the location parameters. The slope parameter γ determines the smoothness of the transition from one regime to another, hence the transition speed. As mentioned before, when γ takes a high value, the transition is completed rapidly; otherwise, the transition is smoother.

In the multiple regime PSTR model, when the transition variable q_{it} is different then the explanatory variable(s), the elasticity is calculated as follows:

$$e_{it} = \frac{\partial y_{it}}{\partial x_{it}} = \beta_0 + \sum_{j=1}^{r} \beta_j' g_j(q_{it}^{(j)}; \gamma_j, c_j) \tag{6}$$

When the transition variable is a function of one of the explanatory variables, i.e. $(q = x)$, the elasticities are estimated as follows:

$$e_{it} = \frac{\partial y_{it}}{\partial x_{it}} = \beta_0 + \sum_{j=1}^{r} \beta_j' g_j(q_{it}^{(j)}; \gamma_j, c_j) + \sum_{j=1}^{r} \beta_j' \frac{\partial g_j(q_{it}^{(j)}; \gamma_j, c_j)}{\partial x_{it}} x_{it} \tag{7}$$

PSTR analysis consists of three steps: testing linearity, determining the number of regimes, and estimation. The linearity test is also used to identify the transition variable (q_{it}) in the PSTR model. For this purpose, the test is applied to all candidate transition variables, and the variable that most strongly rejects the linearity is selected as the transition variable. Testing linearity in the PSTR model can be implemented by testing the null hypotheses $H_0 : \gamma = 0$ or $H_0^* : \beta_1 = 0$. However, the location parameters (c) under both hypotheses, β_1 under hypothesis H_0 and γ under hypothesis H_0^*, are not defined. To solve this problem, Gonzalez et al. (2005) replaced the transition function $g(q_{it};\gamma,c)$ in the PSTR model by its first-order Taylor expansion around $\gamma = 0$. After reparameterization, the following auxiliary regression is obtained:

$$y_{it} = \mu_i + \beta_0^* x_{it} + \beta_1^* x_{it} q_{it} + ... + \beta_m^* x_{it} q_{it}^m + u_{it}^* \tag{8}$$

Testing $H_0 : \gamma = 0$ for the two-regime PSTR model is the same as testing $H_0^* : \beta_1^* = ... = \beta_m^* = 0$ for an auxiliary regression. Therefore, hypotheses where the null hypothesis is the linear model, and the alternative hypothesis is the PSTR model are tested with the standard F-statistic. The relevant F-statistic is estimated as follows:

$$LM_F = \frac{(RSS_0 - RSS_1) / mK}{RSS_0 / (TN - N - mK)} \sim F(1, TN - N - 1) \tag{9}$$

Here, RSS_0 is the sum of the panel error squares of the linear model, while RSS_1 is the sum of the panel error squares of the two-regime PSTR model. According to the LM_F statistic, if the null hypothesis is rejected, the PSTR model may be applied. After rejection of the null hypothesis of linearity, the determination of the number of regimes step is proceeded. At this step, the null hypothesis $H_0 : r = 1$ (the model contains one transition function) is first tested against the alternative hypothesis $H_1 : r = 2$ (the model contains two transition functions). If the null hypothesis is accepted, the process is over. If the null hypothesis is rejected, the null hypothesis $H_0 : r = 2$ is tested against the alternative hypothesis $H_1 : r = 3$. The process of determining the number of regimes lasts until the null hypothesis is accepted. In the estimation step, first, individual effects are eliminated by removing individual-specific means, and then the transformed model is estimated using the Nonlinear Least Squares method.

4. RESULTS AND DISCUSSION

In the panel time series, cross-section dependence and stationarity have to be tested for all panel series before the model estimation steps. Cross-sectional dependence implies that any shock that occurs in a unit affects other units. The results of the analysis, neglecting the existence of this correlation between the units, may be biased and inconsistent. Therefore, as the first step of the analysis, it should be investigated whether there is cross-sectional dependence in all the series. Next, the stationarity of the series should be examined using first-generation panel unit root tests under the assumption that the units are independent from each other; otherwise, second-generation panel unit root tests that take into account cross-sectional dependence should be used.

As the first step of the analysis, the presence of cross-sectional dependence was examined using the Breusch-Pagan CD_{LM} (1980) test, which is more appropriate for the case of $T > N$. While the null hypothesis argues that the units are independent of each other, the alternative hypothesis claims that the cross-sections are dependent on each other. According to the results presented in Table 2, the null hypothesis was rejected at all conventional significance levels for each series and model. This implies that all the series in the panel were dependent on each other, thus proving the existence of cross-sectional dependence.

Table 2. Cross-Sectional Dependence Test Results

Variables	Breusch-Pagan CD_{LM}	
	Statistics	p-value
EF	107.000	0.000***
EGI	232.800	0.000***
lnREP	61.390	0.000***
MODEL	68.030	0.000***

***, **, and * denote 1%, 5%, and 10% significance, respectively.

The second-generation cross-sectionally augmented Im–Pesaran–Shin (CIPS) panel unit root test, developed by Pesaran (2007), which takes into account cross-sectional dependence, was applied to check the stationarity of the series. The results of the CIPS test are given in Table 3. The main hypothesis of the test argues for the existence of a unit root. When the test statistics given in the analysis results were compared with the critical values, the null hypothesis was strongly rejected at all significance levels. Thus, it can be said that all the variables were stationary, both in the model with the constant and in the model with the constant and trend.

Table 3. CIPS Panel Unit Root Test Results

Variables	CIPS	CIPS
	Constant	Constant and Trend
EF	–3.397***	–3.546***
lnREP	–3.532***	–3.942***
EGI	–3.040***	–3.357***
	Critical Values	
1%	–2.55	–3.06
5%	–2.33	–2.84
10%	–2.21	–2.73

***, **, and * denote 1%, 5%, and 10% significance, respectively.

It was decided that PSTR analysis was appropriate according to the results of the cross-sectional dependence and unit root analyses. The first step in PSTR analysis is testing the linearity. The test also shows whether the regime switching in the series is significant or not. In addition, the linearity testing step of the PSTR analysis is also used to determine the transition variable, as suggested by Colletaz and Hurlin (2006). The procedure is iterated for all possible transition variables, and the variable that most strongly rejects the linearity is determined as the transition variable. Table 4 shows the linearity test results of the model in which REP is determined as the transition variable. While the main hypothesis holds that the relationship between economic globalization and environmental pollution is linear, the alternative hypothesis says that there is a nonlinear relationship with at least two regimes. According to the analysis findings, the linearity hypothesis was strongly rejected for both $m=1$ and $m=2$.

Table 4. Linearity Test Results

H_0: Linear model $(r=0)$	$m=1$		$m=2$	
H_1: PSTR model with at least $(r=1)$	Statistics	[p-value]	Statistics	[p-value]
Wald Test (LM)	38.768	[0.000]	52.233	[0.000]
Fisher Test (LM_F)	45.412	[0.000]	32.762	[0.000]
Likelihood Ratio Test (LRT)	42.457	[0.000]	59.249	[0.000]

Source: Authors' estimation. Lagrange Multiplier (LM), Lagrange Multiplier of Fisher (LM_F).

Table 5. Test of No Remaining Nonlinearity Results

H_0: PSTR model with $(r=1)$	$m=1$		$m=2$	
H_1: PSTR model with at least $(r=2)$	Statistics	[p-value]	Statistics	[p-value]
Wald Test (LM)	4.249	[0.039]	3.795	[0.150]
Fisher Test (LM_F)	4.179	[0.042]	1.854	[0.159]
Likelihood Ratio Test (LRT)	4.289	[0.038]	3.826	[0.148]

Source: Authors' estimation.

As mentioned before, when the relationship between variables is found to be nonlinear, the number of regimes should be determined. For this purpose, the analysis was iteratively applied until the null hypothesis could not be rejected. Table 5 shows the test results comparing the model with two regimes against the model with at least three regimes. According to the findings, the two-regime PSTR model with one threshold could not be rejected for $m=1$ and $m=2$. There was a two-regime nonlinear relationship between economic globalization and environmental pollution.

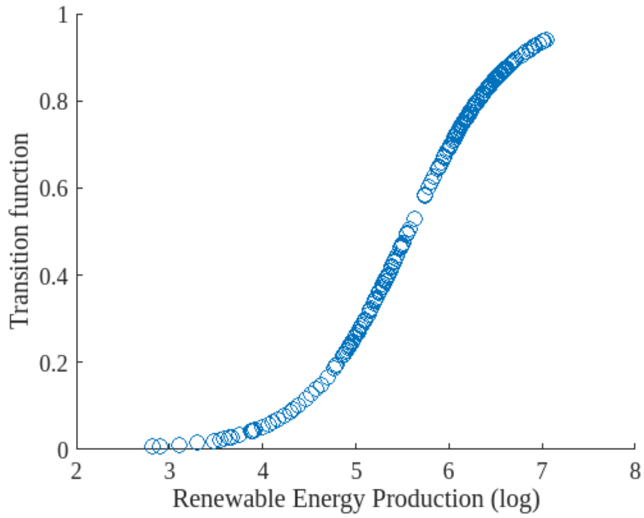
Table 6. Determination of the Appropriate Location Parameter

	$m=1$	$m=2$
RSS	82.818	84.225
AIC	–0.965	–0.935
BIC	–0.905	–0.860

Source: Authors' estimation. Residual sum of squares (RSS), Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC).

The decision on the appropriate location parameter was based on the RSS, AIC, and BIC. The values are provided above, in Table 6. The model with the lowest RSS, AIC, and BIC information criteria was chosen. Thus, the PSTR (1, 1) model with one threshold and one transition function was determined to be the appropriate model.

Figure 1. Estimated Transition Function



The final estimation step of the PSTR model was executed following the determination of the number of regimes and location parameters. Figure 1 shows the transition function plotted against the REP. According to the findings of the two-regime PSTR model with one location parameter analysis given in Table 7, the coefficients were statistically significant. The slope parameter (γ) was determined as 1.8525. This means that the transition between the regimes was smooth. Figure 1 also supports the conclusion that the transition from the low to the high production regime was quite smooth. The threshold value separating these two regimes was 260.2 PJ. According to the graph of the REP given in Figure 2, except for Switzerland in 2021, Switzerland and Denmark were placed entirely in the low production regime, while Sweden, Norway, and France were in the high production regime.

Figure 2. REP Levels of the Countries

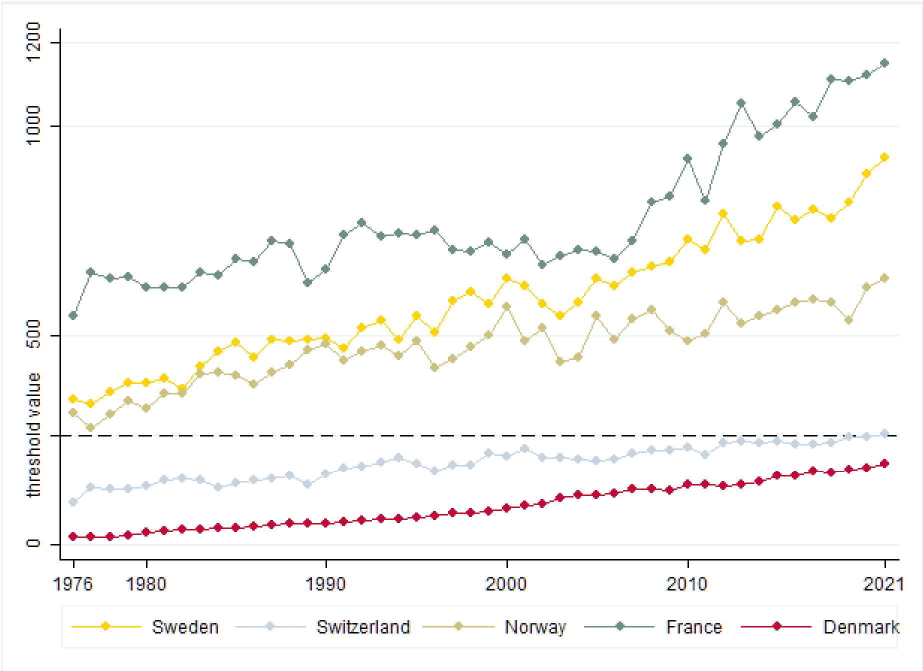


Table 7. PSTR Model Estimation Results

Variables	PSTR (1, 1)	
	β_0	β_1
EGI	0.0806	–0.1092
	(4.7568)[a]	(–8.1686)[a]
Threshold value (c)	5.5615 (260.2 PJ)	
Slope parameter (γ)	1.8525	

[a] Indicates t-statistics corrected for the heteroskedasticity of the coefficients.

The empirical results showed that in the first regime, where the REP was lower than 260.2 PJ, the increase in the level of economic globalization affected the per capita ecological footprint positively $(\beta_0 = 0.0806)$ and caused an aggravation of environmental degradation. However, in the second regime, where the REP was higher than 260.2 PJ, the effect of economic globalization on the ecological footprint switched to negative $(\beta_0 + \beta_1 = 0.0806 - 0.1092)$ and decreased environmental degradation. The results of the first regime, that economic globalization causes environmental degradation, contradict the results of Destek and Özsoy (2015) but are also consistent with the results of Rudolph and Figge (2017), Xu et al. (2018), Phong (2019), Bilgili et al. (2019), Destek (2020), Suki et al. (2020), and Pata (2021). However, considering the results for the second regime, the results are consistent with those of Destek and Özsoy (2015). The current findings showed that although economic globalization is a factor that increases environmental degradation, this effect can be eliminated by increasing REP.

5. CONCLUSION

This paper aimed to investigate how the economic globalization levels of countries affect their environmental performance and, moreover, determine the role of REP in this effect. In order to achieve this, the nonlinear PSTR model was applied to annual data for Sweden, Switzerland, Norway, France, and Denmark for the period of 1976 to 2021. In addition, these countries were not randomly selected; they are the top five best-performing countries according to the Global Green Economy Index 2022 report. It was expected that, due to the high performance of these countries in the field of green economy by adopting environmentally friendly policies, the results may encourage other countries. In this paper, EF data were used to represent environmental pollution, the KOF EGI was used to represent economic globalization, and REP was determined as a transition variable.

The findings suggest that there is a nonlinear, two-regime relationship between environmental pollution and the level of economic globalization. The threshold value separating the regimes was 260.2 PJ, and the transition between regimes was quite smooth. In the first regime, where REP was below the threshold value, economic globalization had a positive effect on the ecological footprint, while this effect switched to negative in the second regime, which was the high production regime. This means that the increase in the level of economic globalization had an increasing impact on environmental degradation; however, this impact was eliminated by increasing REP. Except for Switzerland’s observation in 2021, Switzerland and Denmark were in the low production regime, while Sweden, Norway, and France were in the high production regime. Thus, Switzerland and Denmark, in particular, should consider developing policies to increase REP.

Climate change resulting from environmental degradation has become today’s global crisis. This study showed that one of the causes of this problem is international economic integration, as a result of the industrial development and technological progress of the modern world. This result was reached despite the fact that the countries in the study have been successful in fighting against climate change. Moreover, in a regime where REP is high, this environmental degradation caused by economic integration was eliminated and contributed to environmental quality. Consequently, in order to achieve environmental and sustainable development targets, policymakers are advised to develop policies and implement more investments to promote REP.

The study does not necessitate Ethics Committee permission.

The study has been crafted in adherence to the principles of research and publication ethics.

The authors declare that there exists no financial conflict of interest involving any institution, organization, or individual(s) associated with the article. Furthermore, there are no conflicts of interest among the authors themselves.

The authors contributed equally to the entire process of the research.

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