

## Article

# The Environmental Effects of Urbanization, Education, and Green Innovation in the Union for Mediterranean Countries: Evidence from Quantile Regression Model

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**Abstract:** This study aims to examine the environmental dynamics in the Union for Mediterranean (UFM) countries by considering education, urbanization, green innovation, and other key factors for the period 2001–2016. The data are divided based on the income level of UFM countries and analyzed with panel quantile regression, panel unit root tests, panel co-integration test, ordinary least squares method, and fixed effects model to evaluate the nexus between variables. A generalized method of moments (GMM) is employed to deal with the endogeneity issue in the panel data. The results of the study confirm that the urban population has an inverted U-shaped association with environmental degradation in the lower-middle and high-middle income countries. It further comes out that increased education levels decrease environmental degradation in the high-income countries. Hence, green innovation reduces environmental degradation in the upper-middle-income and high-middle-income countries. The study validates an inverted U-shaped relationship between GDP and environmental degradation in all income-based groups of countries, which supports the Environmental Kuznets Curve (EKC) hypothesis.

**Keywords:** green innovation; urbanization; education; environmental Kuznets curve; quantile regression

## 1. Introduction

Our planet has a limited capacity to assimilate the environmental damage, and our survival is associated with keeping our carbon-intensive global developments within safe limits. However, four out of nine planetary boundaries, including two core boundaries—climate change and biosphere integrity—have been transgressed [1]. Hence, it is estimated that 60% of the world's ecological resources have been exploited, degraded, or overused [2]. The most alarming fact is that we are at the tipping point to make it even worse with just one-fourth of the world's population having achieved a certain level of development, and the other three-quarters of the world are still on their way to imitating the same path motivated by the Western world [3]. Therefore, the need of the time is not only to transform the energy consumption patterns in the developed world but also to enable developing countries to leapfrog the carbon-intensive development path [4] by using cleaner energies, transforming consumption and production, smart urban infrastructures, and innovative lifestyles with inclusive education, where the Mediterranean countries are not the exception.

The Union for the Mediterranean (UFM) is an intergovernmental network of the European Union (EU) and 15 southern and eastern Mediterranean countries with a shared vision to enhance regional stability, integration, and human development. With a 3.6% growth in trade and 6.5% growth in exports, the urban localities of the Mediterranean areas consist of 7% of the world's population, and nearly 80% population of this region is projected to shrink to 10% of the total Mediterranean land by 2030. The southern Mediterranean region is expecting a 62% increase in energy demand by 2040. Between 15% and 32% of young people (15–24) in the southern and eastern Mediterranean countries are not in employment, education, or training (NEETs). The Euro-Mediterranean environment is scaling up equitable opportunities in the region. Despite the stark disparities in the socio-economic development levels of the EU and the southern and eastern Mediterranean countries, the goal of keeping the rise of average temperature below 1.5 °C in the region is almost exceeding the safe limits.

This study utilized the environmental Kuznets curve (EKC) theory and integrated it with ecological modernization theory (EMT) to examine the association of urbanization with environmental degradation. It helps us to conceptualize the transitions to environmental sustainability. It further informs the education level that matters in transitions to environmental sustainability after achieving a certain level of development in a country, and it finally broadens our understanding of the multilevel interplay of multiple factors that might contribute to green innovations in a country: the multilevel perspective (MLP).

The point of the question here is not whether these developments are contributing to degrading the regional and global ecosystems but rather to figure out the form and impact mechanism of urbanization, education, and green innovation in the UFM countries. Do these regional developments follow the linear patterns of carbon-intensive socio-economic developments or deviate from the global trends in any way following the Paris Agreement? How are these developments going to shape or influence the regional environment across different levels and forms of development? With an empirical analysis of the regional trends, this paper provides policy inputs to secure a clean environment in UFM countries. This study finds out the ways how urbanization, education, and green innovations affect environmental degradation and the overall impact in the Mediterranean region.

Mostly, the previous studies have focused on environmental degradation from the investment and energy perspectives; contrarily, this study highlighted new determinants of environmental degradation such as education, urbanization, and green innovation. This study utilized the innovative sample of UFM countries, and it divided the sample based on the income levels of countries for the detailed analysis. This study used rigorous econometric techniques for the analysis purpose such as panel quantile regression, panel unit root tests, panel co-integration test, ordinary least squares method, and a fixed effects model. To deal with the endogeneity issue, a generalized method of moments (GMM) is employed. Moreover, this study employed a robustness test to find more robust results.

The rest of the paper is planned as follows. The second section discusses important theories and findings of previous studies. The third section elaborates on data collection, the sample of the study, and the research methodology used in this study. The fourth section discussed the results of the study. The last section concludes the study along with policy recommendations.

## 2. Literature Review and Theoretical Framework

### 2.1. Environmental Degradation and Urbanization

There are at least six main forms of urbanization-led environmental changes: air and water pollution, ecosystems, solid waste, biogeochemical cycles, land use, and the global climate [5]. It starts from rural–urban migration, resulting in population growth, formal and informal urban settlements, infrastructural development, demographic dynamics, socio-economic inequalities, air pollution, and changes in the local and global environments

[6,7]. However, different theories have different points of view to understanding these urban transitions.

Urban environmental transition theory notes that the impact mechanism of the urban–environmental nexus is very complex, yet some straightforward tendencies can be pointed out: (1) the unintended consequences of human industrial activities when cities become more affluent; (2) the scale of environmental impact varies in poor cities, middle-income cities, and affluent cities; (3) the interconnectedness of cities and environmental issues with linkages to markets and public sector [8].

EMT theorists believe that the impact mechanism of urbanization on the natural environment is variable at different levels of development. When societies' economies take off, environmental problems are not their main concern: they are concerned with economic growth only. However, environmental issues become priority agendas after reaching a satisfactory level of economic growth, educational development, and technological innovation [9].

The compact city theory is more inclined toward positive outcomes of urban development. It notes that densely populated urban areas support the economies of scale in different sectors such as public transportation, schools, hospitals, energy production, etc., which results in reducing environmental damages [10].

The IPAT equation is widely used to understand the multiplicative impact (I) mechanism of three key human developments: population (P), affluence (A), and technology (T) on the environment. It emerged in the early 1970s out of the work of Ehrlich-Holdren/Commoner about the anthropogenic forces of environmental change [11]. One of the criticisms of this empirical model is its rigid proportionality, as it assumes the equal impact of P, A, and T on environmental change [10]. It implies that the rate and range of each factor (population, affluence, or technology), sector (e.g., industry, transport), or a city or country might have variability in the driving force, which is called plasticity [11]. It means the inherent potential for driving impact on the environment and ecological elasticity (EE) measures the proportionate change of anthropogenic effects as a whole.

These accounting equations and the concept of plasticity created space for a stochastic model to test and compute the elasticity of each component categorically called Stochastic Impacts by Regression on Population, Affluence, and Technology (STIRPAT). By using this dynamic and heterogeneous model, Sadorsky [10] investigated the effect of elasticities of urbanization on CO<sub>2</sub> emissions in 16 emergent economies. The estimation indicates that population, affluence, and energy intensity significantly increase CO<sub>2</sub> emissions. The same model (STIRPAT) is applied to another panel on 99 countries where the results confirmed a positive and significant impact of urbanization on CO<sub>2</sub> emissions, but the level of significance is the greatest in the middle-income countries [12]. It shows a linear direction of carbon-intensive global developments. On the contrary, Sharma [13] found that urbanization has a negative but insignificant relationship with carbon emission for all levels of economies. However, Martínez-Zarzoso and Maruotti [14] found that an inverted U-shaped connection is evident in 88 developing countries.

Middle Eastern countries are also a point of focus for several studies. These countries are rich in oil resources, and the revenues generated from it are spent on infrastructure, industrialization, and urbanization. A recent study conducted by Mahmood et al. [15] investigated the asymmetric effects of industrial development and symmetric effects of urban development on CO<sub>2</sub> emission in Saudi Arabia. The study found that both industrial development and urban development are responsible for carbon emissions and environmental degradation in the country. From 1968 to 2014, both nonlinear and linear models found that the elasticity of urbanization is more than one. Being an oil-abundant economy, oil prices play a positive role in urbanization and carbon emission in Saudi Arabia [16]. In the case of the United Arab Emirates (UAE), Shahbaz et al. [17] established a positive association between urban development and carbon emission, an inverted U-shaped connection between economic growth and energy emissions, and confirmed the existence of EKC.

## 2.2. Environmental Degradation and Education

Does education matter in adopting sustainable lifestyles and reducing carbon emissions once a certain level of economic growth is realized in a country?

A recent study conducted by Mahalik et al. [18] examined the role of primary and secondary education in reducing CO<sub>2</sub> emissions in BRICS (Brazil, India, China, South Africa) countries from 1990 to 2015. The results indicated that primary education with other factors including non-renewable energy consumption and globalization leads to increasing CO<sub>2</sub> emissions, while secondary-level education with factors including urban development and renewable energy consumption leads to reducing CO<sub>2</sub> emissions. It specified that not only income growth but education level too deteriorates the environment in the beginning; however, consistent growth at the next level can lead to improving the environmental conditions of a country (EKC). The study suggests promoting higher education in BRICS countries.

Balaguer and Cantavella [19] used higher education data to test the nonlinear relation between education and carbon emission (EKC) in Australia from 1950 to 2014. This paper not only confirmed a U-shaped correlation between income level and its environmental effects but also suggests two opposing effects: (1) in the early stages, education intensifies carbon emission as society continues to use non-renewable energies; (2) later on, education incorporates technical knowledge about cleaner energies; plus, environmental social awareness leads to environmental sustainability. This article notes that Australian society turned its consumption patterns after achieving 52,043 Australian Dollars per capita corresponding to the year 1997 and suggests investigating the education effects on the environment beyond the effects of economic growth.

However, Zafar et al. [20] noted from the 24th conference of parties (COP24) that not only emergent nations that are struggling to achieve the turning level of economic growth for their people but also developed nations with high per capita income and education levels including the USA are expected to increase carbon emissions by 2.5%. Therefore, they analyzed the role of education in EKC in 27 OECD from 1990 to 2015. They confirmed a U-shaped Kuznets curve with the rise of education with the following impact mechanisms: with increasing levels of education, the vocational training opportunities increase depending rise in fossil fuel energy demand, but at a later stage, these economic and education sectors grow with environmental social awareness, which leads to the production and consumption of cleaner energies and CO<sub>2</sub> emissions reduction. However, the study noted that this process is not automatic. Education leads to a turning point when economies are at stake due to the increased demand for cleaner consumption and environmental protection law enforcement. It shows that institutionalization plays a vital role.

Furthermore, Tang et al. [21] tested the moderating role of institutions in changing the environmental conditions in 114 countries. They found that the institutional capacity of a country facilitates the impact of FDI and cleaner energies to effectively minimize environmental degradation. They suggested strengthening the governance system and protective laws against the viral inflow of FDI for the short-term economic fixes by compromising the long-term environmental cost-efficiency myopia [22].

Energy efficiency, Sun et al. [23] argued, is the outcome of the strong backing of governmental institutions to invest in green technologies to innovate the low-carbon development of a country. They examined the energy efficiency data of 71 developing and developed countries from 1990 to 2014. The results revealed a positive association of institutional quality and green innovation with energy efficacy.

The conjunction of different findings under the above sections (education and urbanization) reveals that innovating change or leading a country/society to a turning point (EKC) is not a solo factor task but the interplay of multilevel factors.

### 2.3. Environmental Degradation and Green Innovation

Green innovation is a process of transforming our technologies for cleaner production and sustainable consumption [24]. Castellacci and Lie [25] defined green innovation as a process of creating new production technologies for reducing resource exploitation and environmental risks. The key is to understand these processes or pathways through which a city, society, or a country ingrain these innovations into its development practices.

The multilevel perspective (MLP) [26] viewed transitions toward green innovation as a nonlinear interplay of multilevel components and actors at three analytical levels: niches (grassroot radical innovations), socio-technical regime (mid-level established practices), and socio-technical setting (high-level stable influential). Niches are considered protected places where entrepreneurs, spinoffs, and start-ups are willing to innovate something deviating from the ongoing practices. The success of such novelties depends on the availability of appropriate socio-technical infrastructures such as markets, industry, technology, science and culture, and supportive regulations at the regime level. It further depends on whether political ideologies, demographic trends, and macro-economic patterns uplift these niche innovations from socio-technical regimes to the socio-technical landscape.

Yuan et al. [27] studied the impact mechanism of green innovation by studying the panel data of 30 provinces in two different periods: 2005 to 2012 and 2013 to 2017. The study finds that environmental risks are reduced during the second term (2013 to 2017) due to the better institutionalization of organizational structures, market methods, and sustained economic development in China.

Rather than simply studying the association of single environmental regulation with green innovation, Luo et al. [28] studied the synergistic effects of multiple environmental regulations, indigenous innovation inputs, and FDI (inward and outward) on green innovation from 2003 to 2017 in China. The results revealed that China's command-and-control regulations where they allocated provincial-level emission reduction targets significantly promoted green technological innovation, which validates Porter's hypothesis. It further informed that inward FDI supports green technology spillover, it approves the Pollution Halo Hypothesis, and outward FDI also enhances China's ability of green innovation.

Singh et al. [29] examined the mediating role of leadership in innovating green human resource management (HRM) practices in markets by collecting data from 309 small and medium-sized enterprises (SMEs). It informed that green transformational leadership leads to human resource ability, motivation, and opportunity for processing green production and environmental performance.

Technological innovations play a vital role in cleaner energies, structural changes in the production process, and environmental quality [30]; however, De Jesus et al. [31] believed that transitions toward green or eco-innovation depend on holistic and systematic maneuvers beyond technological innovations.

## 3. Data, Sample, and Research Methods

### 3.1. Data and Sample

The sample of this study consists of Mediterranean countries classified into four categories based on income levels such as lower-middle-income countries, upper-middle-income countries, and high-income countries, according to the world development indicators. The panel data of countries cover the period from 2001 to 2016. Data are collected from the World Bank, Organization for Economic Co-operation and Development (OECD), and Global Footprint Network.

### 3.2. Model Specification

This paper formulated the model by integrating two famous theories: ecological modernization theory (EMT) and environmental Kuznets curve (EKC) theory. Ecological modernization theory (EMT) describes how industrialized countries deal with environmental challenges. EMT emphasizes that continued industrialization offers the best choice for evading the global ecological challenges [11]. EKC theory exhibits the association between environment and income level. At the start of economic development, the environment is severely affected; resultantly, the environmental quality declines. However, after attaining a certain level of income, the situation is changed. With an increased level of income, economic development leads to improved environmental quality. EKC theory suggests the U-shaped association between environment and income level [32,33].

We utilized the EKC theory and integrated it with the EMT theory to examine the association of urbanization with environmental degradation based on the income levels of Mediterranean countries. Kuznets [34] firstly proposed the EKC theory in 1955 to elaborate on the nexus of environment and income level. This study followed prior studies conducted by Shahbaz et al. [35] and Muhammad, Long, Salman and Dauda [9] to extend the EKC model by adding energy consumption, education, population, green innovation, exports, FDI, GDP, and imports.

We used quantile regression [36] to analyze the nexus between environmental degradation, urbanization, education, and green innovation. It is a more reliable technique to examine the dependent variable in a better way by identifying the conditional distributions of variables over the years [37]. This technique is also helpful to deal with heteroskedastic issues. It provides the median value of variables of interest and fits the regression model by reducing the absolute residuals. Conventional OLS may provide biased results because it fails to measure the skewness of data; contrary to the conventional OLS, quantile regression deals with this issue. This technique also accounts for covariate effects at different levels of conditional distributions of variables (Muhammad, Long, Salman, and Dauda (2020)).

We examined the quantile regression estimation of variables at six levels of quantiles such as 15th, 30th, 45th, 60th, 75th, and 90th. The extended form of the EKC model for quantile regression is given below:

$$Q_{\tau} \ln EDD_{it} = \gamma_{\tau} + \gamma_{1\tau} \ln EDU_{it} + \gamma_{2\tau} \ln INOV_{it} + \gamma_{3\tau} \ln UP_{2,it} + \gamma_{4\tau} \ln FDI_{it} + \gamma_{5\tau} \ln GDP_{it} + \gamma_{6\tau} \ln POP_{it} + \gamma_{7\tau} \ln EC_{it} + \gamma_{8\tau} \ln EXP_{it} + \gamma_{9\tau} \ln IMP_{it} + \gamma_{10\tau} \ln FD_{it} + \pi_{it}$$

where  $Q_{\tau}$  is a quantile regression parameter, EDD denotes environmental degradation, EDU denotes education, INOV denotes green innovation, UP, FDI, GDP, POP, EC, EXP, IMP, and FD stand for urban population, foreign direct investment, gross domestic product, population, energy consumption, exports, imports, and financial development, respectively.

## 4. Results and Discussion

### 4.1. Summary Statistics

Table 1 describes the variables in terms of mean, standard deviation, minimum, and maximum values. It also defines the measures of variables and sources of data for each variable.

**Table 1.** Summary Statistics, Measures and Sources.

| Symbol | Variable Description                              | Mean    | SD     | Min     | Max     | Source                   |
|--------|---------------------------------------------------|---------|--------|---------|---------|--------------------------|
| LNEDD  | Ecological footprints per capita                  | 1.4928  | 0.4835 | 0.3269  | 2.8749  | Global Footprint Network |
| LNEDU  | School enrollment, secondary (% gross)            | 4.6024  | 0.1796 | 3.7014  | 5.0995  | World Bank               |
| LNINOV | Environment-related technologies (%)              | 2.3331  | 0.5328 | −0.1278 | 3.9040  | OECD                     |
| LNUP   | Urban population (% of total population)          | 4.2360  | 0.1961 | 3.7480  | 4.5841  | World Bank               |
| LNFDI  | Foreign direct investment, net (BoP, current USD) | 25.9231 | 0.1441 | 24.1265 | 26.5168 | World Bank               |
| LNGDP  | GDP per capita (current USD)                      | 9.6297  | 1.0489 | 6.9689  | 11.6854 | World Bank               |
| LNPOP  | Population, total                                 | 16.0014 | 1.3683 | 12.8816 | 18.3636 | World Bank               |

|       |                                                  |         |        |         |         |            |
|-------|--------------------------------------------------|---------|--------|---------|---------|------------|
| LNEDD | Energy use (kg of oil equivalent per capita)     | 7.8135  | 0.6377 | 5.9837  | 9.1515  | World Bank |
| LNEXP | Exports of goods and services (current USD)      | 24.8528 | 1.4761 | 20.5450 | 28.2030 | World Bank |
| LNIMP | Imports of goods and services (current USD)      | 24.9013 | 1.3749 | 21.2949 | 28.0463 | World Bank |
| LNFD  | Domestic credit to the private sector (% of GDP) | 4.2336  | 0.7074 | −2.3023 | 5.5425  | World Bank |

#### 4.2. Unit Root Test

This study employed the Fisher Augmented Dickey–Fuller (ADF) test and Fisher Phillips Perron (PP) test to identify the stationarity of variables. The results are shown in Table 2, which are helpful to decide whether the series fulfills the property of stationarity or not. The probability values of each variable indicate that variables are non-stationary at level. After taking the first difference, variables are converted into stationary form to avoid biased results. The results of variables fulfill the stationary property and support employing co-integration/regression models.

**Table 2.** Unit Root Test.

|                | Variables | Fisher ADF Stat. | Prob.  | Fisher PP Stat. | Prob.  |
|----------------|-----------|------------------|--------|-----------------|--------|
| At Level       | LNEDD     | 58.3972          | 0.8373 | 110.884 ***     | 0.0013 |
|                | LNEDU     | 62.7319          | 0.7191 | 77.7081         | 0.2467 |
|                | LNINOV    | 165.103 ***      | 0.000  | 176.242 ***     | 0.000  |
|                | LNUP      | 74.4407          | 0.3359 | 237.898 ***     | 0.000  |
|                | LNFDI     | 97.7743 **       | 0.0158 | 202.97 ***      | 0.000  |
|                | LNGDP     | 194.751 ***      | 0.000  | 396.795 ***     | 0.000  |
|                | LNPOP     | 83.4751          | 0.1295 | 78.5256         | 0.2269 |
|                | LNED      | 47.5918          | 0.9815 | 50.5165         | 0.9618 |
|                | LNEXP     | 184.723 ***      | 0.000  | 423.838 ***     | 0.000  |
|                | LNIMP     | 136.812 ***      | 0.000  | 375.116 ***     | 0.000  |
| 1st Difference | LNFD      | 165.26 ***       | 0.000  | 142.397 ***     | 0.000  |
|                | LNEDD     | 198.334 ***      | 0.000  | 442.496 ***     | 0.000  |
|                | LNEDU     | 133.645 ***      | 0.000  | 244.727 ***     | 0.000  |
|                | LNINOV    | 403.056 ***      | 0.000  | 518.381 ***     | 0.000  |
|                | LNUP      | 110.56 ***       | 0.0014 | 121.275 ***     | 0.0001 |
|                | LNFDI     | 436.539 ***      | 0.000  | 498.206 ***     | 0.000  |
|                | LNGDP     | 116.952 ***      | 0.0004 | 149.323 ***     | 0.000  |
|                | LNPOP     | 189.077 ***      | 0.000  | 105.899 ***     | 0.0036 |
|                | LNED      | 174.494 ***      | 0.000  | 390.68 ***      | 0.000  |
|                | LNEXP     | 128.828 ***      | 0.000  | 200.065 ***     | 0.000  |
|                | LNIMP     | 193.901 ***      | 0.000  | 194.736 ***     | 0.000  |
|                | LNFD      | 167.116 ***      | 0.000  | 205.433 ***     | 0.000  |

Note: Figures symbolize significance at 1% (\*\*\*) and 5% (\*\*).

#### 4.3. Co-Integration Test

This study employed the Kao panel co-integration test to examine the connection between environmental degradation, green innovation, education, and other variables; the results are shown in Table 3. The null hypothesis of the Kao test suggests that there is no co-integration among variables. The results of both panel and income-based groups of countries show that ADF statistics of the Kao test reject the null hypothesis at the 1% level. It confirms the existence of cointegration among determinants of environmental degradation at the panel and income levels.

**Table 3.** Kao Test of Co-Integration.

| Tests             | Panel       | Lower-Middle Income | Upper-Middle Income | High Income |
|-------------------|-------------|---------------------|---------------------|-------------|
| ADF Stat          | −3.1285 *** | −6.0454 ***         | −3.1041 ***         | −2.8855 *** |
| Residual Variance | 0.0062      | 0.0026              | 0.0027              | 0.0070      |
| HAC Variance      | 0.0039      | 0.0011              | 0.0017              | 0.0043      |

Note: Figures symbolize significance at 1% (\*\*\*)

#### 4.4. Quantile Regression

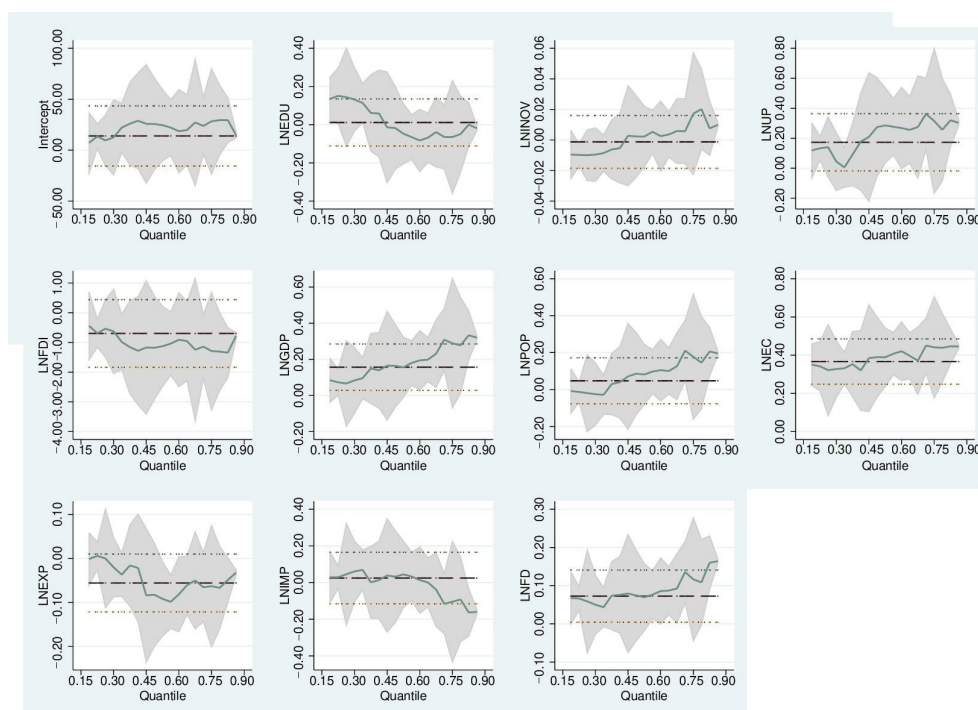
Table 4 highlights the results of quantile regression for lower-middle income countries. The results show that education has a significant positive association with environmental degradation at the 5% level in the 15th quantile. Urban population significantly positively affects environmental degradation in 45th, 75th, and 90th quantiles, while it has an insignificant association with environmental degradation in the 15th and 30th quantiles. FDI significantly negatively affects environmental degradation at the 1% level in the 90th quantile, which is insignificant in all other quantiles. The coefficient value of GDP demonstrates a significant positive inclination to environmental degradation in the 45th, 75th, and 90th quantiles. The population has a significant positive inclination to environmental degradation in the 75th and 90th quantiles. Energy consumption increases environmental degradation at the 1% level across quantiles except for the 60th quantile. Exports have a significant negative association with environmental degradation in the 45th and 90th quantiles, while it is insignificant in other quantiles. The coefficient values of imports exhibit a significant negative effect on environmental degradation at a 1% level in the 90th quantile. Financial development is significantly positively inclined to environmental degradation in the 30th, 45th, 75th, and 90th quantiles. Finally, results established the inverted U-shaped association of urban population with environmental degradation. These results correlate with the findings of previous studies [9,38]. For instance, Muhammad, Long, Salman and Dauda [9] found an inverted U-shaped of urban population with CO<sub>2</sub> emissions in belt and road initiative (BRI) countries with high income. Moreover, Zhang, Yu and Chen [38] confirmed an inverted U-shaped association between urban population and environmental degradation by studying the data of 141 countries. Contrarily, Shahbaz, Sbia, Hamdi and Ozturk [17] found a positive association between urbanization and CO<sub>2</sub> emissions by studying the data of United Arab Emirates (UAE).

**Table 4.** Quantile Regression Results (Lower-Middle Income Countries).

| Variables | OLS                    | 15th                   | 30th                   | 45th                   | 60th                 | 75th                   | 90th                    |
|-----------|------------------------|------------------------|------------------------|------------------------|----------------------|------------------------|-------------------------|
| LNEDU     | 0.0115<br>(0.0615)     | 0.1439 **<br>(0.0549)  | 0.0614<br>(0.0956)     | −0.0175<br>(0.0793)    | −0.0828<br>(0.0792)  | −0.0642<br>(0.0771)    | 0.0003<br>(0.0389)      |
| LNINOV    | −0.0013<br>(0.0086)    | −0.0100<br>(0.0077)    | −0.0062<br>(0.0134)    | 0.0023<br>(0.0111)     | 0.0025<br>(0.0111)   | 0.0057<br>(0.0108)     | 0.0076<br>(0.0054)      |
| LNUP      | 0.1730 *<br>(0.0952)   | 0.1409<br>(0.0849)     | 0.0913<br>(0.1479)     | 0.2749 **<br>(0.1226)  | 0.2680<br>(0.1225)   | 0.3625 ***<br>(0.1193) | 0.3200 ***<br>(0.0602)  |
| LNFDI     | −0.6974<br>(0.5675)    | −0.5337<br>(0.5063)    | −1.1569<br>(0.8818)    | −1.1783<br>(0.7313)    | −0.9083<br>(0.7305)  | −1.1403<br>(0.7112)    | −1.3424 ***<br>(0.3589) |
| LNGDP     | 0.1564 **<br>(0.0640)  | 0.0663<br>(0.0571)     | 0.1497<br>(0.0995)     | 0.1639 *<br>(0.0825)   | 0.1944<br>(0.0824)   | 0.3085 ***<br>(0.0802) | 0.3330 ***<br>(0.0405)  |
| LNPOP     | 0.0475<br>(0.0620)     | −0.0192<br>(0.0553)    | 0.0301<br>(0.0964)     | 0.0863<br>(0.0799)     | 0.1052<br>(0.0798)   | 0.2109 ***<br>(0.0777) | 0.2060 ***<br>(0.0392)  |
| LNEC      | 0.3664 ***<br>(0.0591) | 0.3217 ***<br>(0.0528) | 0.3527 ***<br>(0.0919) | 0.3899 ***<br>(0.0762) | 0.4206<br>(0.0761)   | 0.4503 ***<br>(0.0741) | 0.4465 ***<br>(0.0374)  |
| LNEXP     | −0.0558 *<br>(0.0328)  | 0.0000<br>(0.0292)     | −0.0159<br>(0.0509)    | −0.0826 *<br>(0.0422)  | −0.0815<br>(0.0422)  | −0.0655<br>(0.0411)    | −0.0490 **<br>(0.0207)  |
| LNIMP     | 0.0246<br>(0.0701)     | 0.0452<br>(0.0625)     | 0.0010<br>(0.1089)     | 0.0321<br>(0.0903)     | 0.0135<br>(0.0902)   | −0.1156<br>(0.0878)    | −0.1635 ***<br>(0.0443) |
| LNFD      | 0.0725 **<br>(0.0340)  | 0.0588 *<br>(0.0304)   | 0.0739 (0.0529)        | 0.0742 *<br>(0.0439)   | 0.0858<br>(0.0438)   | 0.1357 ***<br>(0.0426) | 0.1600 ***<br>(0.0215)  |
| _cons     | 13.9217<br>(14.7072)   | 9.5879<br>(13.1213)    | 25.9727<br>(22.8518)   | 25.6584<br>(18.9502)   | 18.5905<br>(18.9306) | 23.7643<br>(18.4308)   | 29.4957 ***<br>(9.3015) |

Note: Figures symbolize significance at 1% (\*\*\*), 5% (\*\*) and 10% (\*); Stand. Errors are reported in ().

Figure 1 shows the quantile distribution graphs for lower-middle income countries. In this figure, dotted lines on both sides represent OLS estimated coefficients at the 95% level, whereas the line in green color represents the coefficients at different quantiles. The dappled portion between dotted lines shows the upper and lower limits of the 95% level. Figure 1 exhibits that OLS estimated coefficients are fixed across quantile distributions of environmental degradation, whereas the green line varies at each quantile distribution of environmental degradation.



**Figure 1.** Quantile Distribution for Lower-Middle Income Countries.

Table 5 shows the results of quantile regression for upper-middle income countries. The results demonstrate that education significantly positively affects environmental degradation at the 1% level in the 15th and 90th quantiles. Green innovation has a significant negative effect on environmental degradation at the 5% level in the 90th quantile. The urban population is significantly negatively inclined to environmental degradation at different levels in the 45th, 60th, and 75th quantiles. The coefficient of FDI implies a significantly positive association with environmental degradation at 10% in the 90th quantile. The coefficient of GDP also suggests a significantly positive association with environmental degradation at different levels in the 15th, 30th and 90th quantiles. The population is also significantly positively inclined to environmental degradation at different levels in the 15th and 30th quantiles. The coefficient of energy consumption implies a significant positive effect on environmental degradation at the 1% level in the 15th, 30th, 45th, 60th, 75th, and 90th quantiles. Exports are significantly negatively inclined to environmental degradation at different levels in the 15th, 30th, 45th and 90th quantiles. The coefficient of imports implies a significantly positive association with environmental degradation at the 5% level in the 15th quantile. Financial development is significantly negatively inclined to environmental degradation at the 1% level in the 15th quantile. Finally, the results for upper-middle-income countries highlighted the negative relationship of green innovation and urban population with environmental degradation, while education showed a positive association with environmental degradation. These results correlate with the outcomes of prior studies. For instance, Balaguer and Cantavella [19] confirmed the positive association of education with per capita CO<sub>2</sub> in most of the studied period by analyzing the Australian data. Contrarily, Zafar, Shahbaz, Sinha, Sengupta and Qin [20] revealed an inverse relationship between education and environmental degradation by studying the sample of OECD countries.

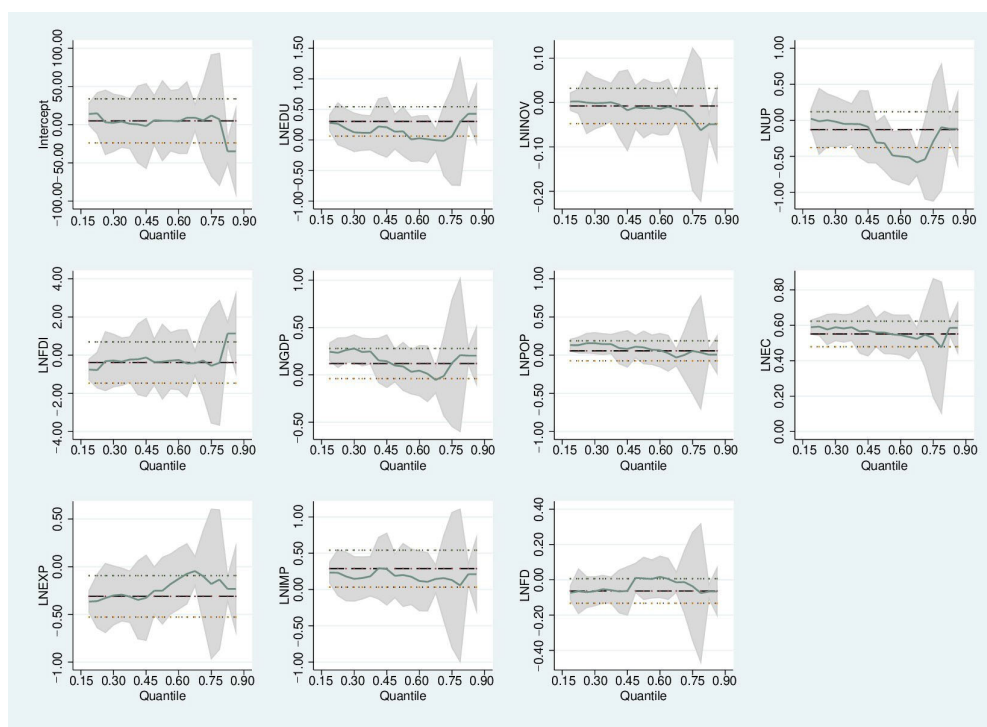
**Table 5.** Quantile Regression Results (Upper-Middle-Income Countries).

| Variables | OLS | 15th | 30th | 45th | 60th | 75th | 90th |
|-----------|-----|------|------|------|------|------|------|
|-----------|-----|------|------|------|------|------|------|

|        |                         |                         |                        |                        |                        |                        |                          |
|--------|-------------------------|-------------------------|------------------------|------------------------|------------------------|------------------------|--------------------------|
| LNEDU  | 0.3031 **<br>(0.1196)   | 0.1873 ***<br>(0.0685)  | 0.1178 (0.1354)        | 0.1360 (0.1593)        | 0.0277 (0.1819)        | −0.0132<br>(0.2030)    | 0.4283 ***<br>(0.1378)   |
| LNINOV | −0.0077 (0.0199)        | −0.0001<br>(0.0114)     | 0.0005 (0.0225)        | −0.0109<br>(0.0265)    | −0.0143<br>(0.0302)    | −0.0196<br>(0.0337)    | −0.0490 **<br>(0.0229)   |
| LNUP   | −0.1295 (0.1237)        | 0.0018 (0.0709)         | −0.0503<br>(0.1401)    | −0.3080 *<br>(0.1648)  | −0.5005 **<br>(0.1881) | −0.5403 **<br>(0.2100) | −0.1183<br>(0.1426)      |
| LNFDI  | −0.3866 (0.5377)        | −0.3162<br>(0.3080)     | −0.2303<br>(0.6089)    | −0.3637<br>(0.7163)    | −0.2499<br>(0.8178)    | −0.2829<br>(0.9127)    | 1.1333 *<br>(0.6196)     |
| LNGDP  | 0.1195 (0.0794)         | 0.2619 ***<br>(0.0454)  | 0.2474 ***<br>(0.0899) | 0.0989 (0.1057)        | 0.0445 (0.1207)        | −0.0119<br>(0.1347)    | 0.2028 **<br>(0.0914)    |
| LNPOP  | 0.0567 (0.0652)         | 0.1564 ***<br>(0.0373)  | 0.1451 *<br>(0.0738)   | 0.1109 (0.0868)        | 0.0654 (0.0992)        | 0.0022 (0.1107)        | 0.0061 (0.0751)          |
| LNEC   | 0.5514 ***<br>(0.0361)  | 0.5765 ***<br>(0.0207)  | 0.5892 ***<br>(0.0408) | 0.5598 ***<br>(0.0480) | 0.5449 ***<br>(0.0548) | 0.5475 ***<br>(0.0612) | 0.5859 ***<br>(0.0416)   |
| LNEXP  | −0.3106 ***<br>(0.1083) | −0.3285 ***<br>(0.0620) | −0.3147 **<br>(0.1227) | −0.2521 *<br>(0.1443)  | −0.1267<br>(0.1648)    | −0.1008<br>(0.1839)    | −0.2328 *<br>(0.1248)    |
| LNIMP  | 0.2881 **<br>(0.1272)   | 0.1809 **<br>(0.0728)   | 0.1830 (0.1440)        | 0.1889 (0.1694)        | 0.1179 (0.1934)        | 0.1576 (0.2159)        | 0.2118 (0.1466)          |
| LNFD   | −0.0634 *<br>(0.0346)   | −0.0699 ***<br>(0.0198) | −0.0589<br>(0.0392)    | 0.0107 (0.0461)        | 0.0167 (0.0527)        | −0.0132<br>(0.0588)    | −0.0666<br>(0.0399)      |
| _cons  | 4.9922 (14.3739)        | 3.0605 (8.2321)         | 1.1774<br>(16.2773)    | 5.8447<br>(19.1460)    | 4.2474<br>(21.8592)    | 5.5170<br>(24.3977)    | −34.8904 **<br>(16.5628) |

Note: Figures symbolize significance at 1% (\*\*\*), 5% (\*\*) and 10% (\*); Stand. Errors are reported in ().

Figure 2 demonstrates the quantile distribution graphs for upper-middle income countries. There are dotted lines on both sides in Figure 2, which represent OLS estimated coefficients at the 95% level, whereas the green line represents the coefficients at different quantiles. The dappled portion between dotted lines shows the upper and lower limits of the 95% level. This figure shows that OLS estimated coefficients are fixed across quantile distributions of environmental degradation, whereas the green line varies at each quantile distribution of environmental degradation.



**Figure 2.** Quantile Distribution for Upper-Middle-Income Countries.

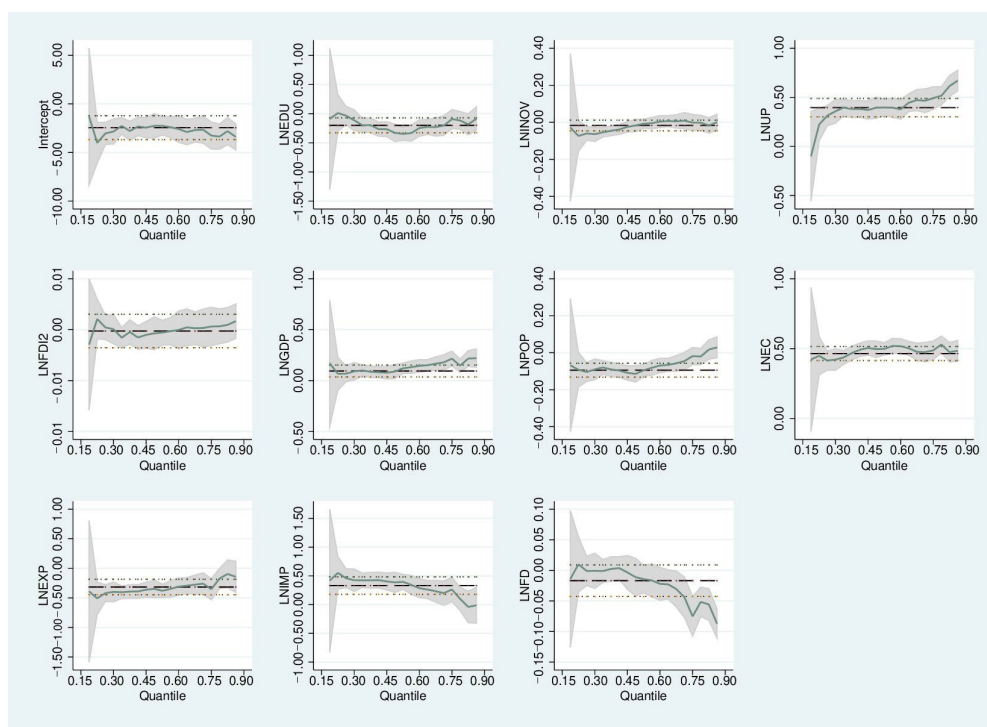
Table 6 shows the results of quantile regression for a high income group of countries. The results indicate that education significantly negatively affects environmental degradation at different levels in the 30th, 45th, 60th, 75th, and 90th quantiles. Innovation has a significant and negative effect on environmental degradation at different levels in the 15th and 30th quantiles. The coefficient of the urban population indicates a significantly positive effect on environmental degradation at the 1% level across quantiles. GDP is significantly positively inclined to environmental degradation at different levels across quantiles. The coefficient of the population demonstrates a significant negative effect on the environmental degradation in the 15th, 30th, 45th, and 60th quantiles. Energy consumption is significantly negatively inclined to environmental degradation at different levels across quantiles. The coefficient of exports indicates a significantly negative effect on environmental degradation at different levels in the 15th, 30th, 45th and 60th quantiles. Imports are significantly positively inclined to environmental degradation at different levels in the 15th, 30th, 45th and 60th quantiles. Financial development indicates a significantly negative effect on environmental degradation in the 75th and 90th quantiles. Finally, the results indicated an inverted U-shaped association between urban population and environmental degradation and an inverse relationship between education and innovation with environmental degradation. These results are similar to the outcomes of previous studies [20,38]. For instance, Zafar, Shahbaz, Sinha, Sengupta and Qin [20] revealed an inverse relationship between education and environmental degradation by studying the sample of OECD countries. Moreover, Zhang, Yu and Chen [38] confirmed an inverted U-shaped association between urban population and environmental degradation by studying the data of 141 countries. Contrarily, Shahbaz, Sbia, Hamdi and Ozturk [17] found a positive association between urbanization and CO<sub>2</sub> emissions by studying the data of United Arab Emirates (UAE).

**Table 6.** Quantile Regression Results (High Income Countries).

| Variables | OLS                     | 15th                    | 30th                    | 45th                    | 60th                    | 75th                    | 90th                    |
|-----------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| LNEDU     | −0.2002 ***<br>(0.0655) | −0.0328<br>(0.0842)     | −0.1972 **<br>(0.0817)  | −0.3287 ***<br>(0.0772) | −0.2467 ***<br>(0.0724) | −0.2052 **<br>(0.1021)  | −0.1828 *<br>(0.0972)   |
| LNINOV    | −0.0170<br>(0.0147)     | −0.0602 ***<br>(0.0189) | −0.0456 **<br>(0.0184)  | −0.0171<br>(0.0174)     | 0.0040 (0.0163)         | 0.0086<br>(0.0229)      | −0.0169<br>(0.0219)     |
| LNUP      | 0.3951 ***<br>(0.0477)  | 0.3135 ***<br>(0.0614)  | 0.3808 ***<br>(0.0595)  | 0.3949 ***<br>(0.0563)  | 0.3778 ***<br>(0.0528)  | 0.4653 ***<br>(0.0744)  | 0.6145 ***<br>(0.0709)  |
| LNFDI     | −0.0001<br>(0.0008)     | 0.0002 (0.0011)         | −0.0002<br>(0.0010)     | −0.0004<br>(0.0010)     | 0.0000 (0.0009)         | 0.0002<br>(0.0013)      | 0.0005<br>(0.0012)      |
| LNGDP     | 0.0947 ***<br>(0.0296)  | 0.0682 *<br>(0.0381)    | 0.0871 **<br>(0.0369)   | 0.0892 **<br>(0.0349)   | 0.1452 ***<br>(0.0327)  | 0.1792 ***<br>(0.0461)  | 0.2169 ***<br>(0.0440)  |
| LNPOP     | −0.0942 ***<br>(0.0191) | −0.1042 ***<br>(0.0246) | −0.0901 ***<br>(0.0239) | −0.1142 ***<br>(0.0226) | −0.0692 ***<br>(0.0212) | −0.0450<br>(0.0298)     | 0.0172<br>(0.0284)      |
| LNEC      | 0.4646 ***<br>(0.0256)  | 0.4143 ***<br>(0.0330)  | 0.4678 ***<br>(0.0320)  | 0.4959 ***<br>(0.0302)  | 0.5174 ***<br>(0.0283)  | 0.4751 ***<br>(0.0400)  | 0.4746 ***<br>(0.0381)  |
| LNEXP     | −0.3160 ***<br>(0.0664) | −0.4189 ***<br>(0.0854) | −0.3931 ***<br>(0.0828) | −0.3466 ***<br>(0.0783) | −0.3099 ***<br>(0.0734) | −0.2583 **<br>(0.1034)  | −0.0950<br>(0.0985)     |
| LNIMP     | 0.3309 ***<br>(0.0771)  | 0.4597 ***<br>(0.0993)  | 0.4223 ***<br>(0.0963)  | 0.3872 ***<br>(0.0910)  | 0.2863 ***<br>(0.0853)  | 0.2002 *<br>(0.1203)    | −0.0404<br>(0.1146)     |
| LNFD      | −0.0169<br>(0.0131)     | −0.0010<br>(0.0169)     | 0.0023 (0.0164)         | −0.0111<br>(0.0155)     | −0.0221<br>(0.0145)     | −0.0440 **<br>(0.0205)  | −0.0557 ***<br>(0.0195) |
| _cons     | −2.446 ***<br>(0.6250)  | −3.035 ***<br>(0.8042)  | −2.792 ***<br>(0.7799)  | −2.2626 ***<br>(0.7371) | −2.5866 ***<br>(0.6915) | −2.6563 ***<br>(0.9745) | −2.8013 ***<br>(0.9282) |

Note: Figures symbolize significance at 1% (\*\*\*), 5% (\*\*) and 10% (\*); Stand. Errors are reported in ().

Figure 3 exhibits the quantile distribution graphs for high income group of countries. It has dotted lines on both sides, which shows coefficients estimated by OLS at the 95% level, while the green line signifies the coefficients at different quantiles. The dappled portion between dotted lines displays the upper and lower limits of the 95% level. This figure implies that coefficients estimated by OLS are fixed in all quantile distributions of environmental degradation, while the green line differs at each quantile distribution of environmental degradation.



**Figure 3.** Quantile Distribution for High-Income Countries.

#### 4.5. Robustness Test

To find more robust results, we employed a robustness test by replacing the measure of the dependent variable with CO<sub>2</sub> emission; the results are displayed in Table 7. The results of the robustness test are almost consistent with the results of quantile regression. Education has a significantly negative effect on environmental degradation at different levels in the high-income group and overall panel of countries. The coefficient of innovation indicates a significantly negative effect on environmental degradation at the 5% level in the high-income group and overall panel of countries. The urban population is significantly positively inclined to environmental degradation at the 1% level in the upper-middle group of countries, whereas it is significantly negatively inclined to environmental degradation at the 1% level in the lower-income group. GDP is significantly positively inclined to environmental degradation at the 5% level in the group of countries, while it is significantly negatively inclined to environmental degradation at the 10% level. Population has a significantly negative effect on environmental degradation at different levels in the panel and different income-based groups of countries. Energy consumption has a significantly positive effect on environmental degradation at the 1% level in the panel and different income-based groups of countries. Exports have a significantly negative effect on environmental degradation at different levels in the high-income group, upper-middle-income group, and panel of countries, while it significantly positively affects environmental degradation at the 1% level in the lower-middle-income countries. The coefficient of imports indicates a significantly positive effect on environmental degradation at different levels in high and upper-middle-income countries. Financial development significantly negatively affects environmental degradation at different levels in the high-income group and panel of countries, while it shows a significant positive effect on environmental degradation at different levels in the upper-middle group and lower-middle group.

**Table 7.** Robustness Test Results for Panel and Different Income Groups.

| Variables    | Panel                | High Income          | Upper-Middle Income | Lower-Middle Income  |
|--------------|----------------------|----------------------|---------------------|----------------------|
| LNEDU        | −0.1381 *** (0.0421) | −0.1315 ** (0.0574)  | 0.1475 (0.1690)     | 0.0247 (0.0619)      |
| LNINOV       | −0.0139 ** (0.0061)  | −0.0190 ** (0.0074)  | −0.0096 (0.0177)    | 0.0103 (0.0062)      |
| LNUP         | 0.1673 (0.1283)      | −0.3196 (0.1966)     | 1.0449 *** (0.3562) | −1.4139 *** (0.4650) |
| LNFDI        | −0.0002 (0.0202)     | −0.0131 (0.0196)     | −0.3994 (0.4664)    | 0.6041 (0.3864)      |
| LNGDP        | 0.0861 ** (0.0348)   | −0.0315 (0.0459)     | −0.0647 (0.1434)    | −0.0968 * (0.0533)   |
| LNPOP        | −0.2568 *** (0.0646) | −0.5766 *** (0.0972) | −0.3599 ** (0.1424) | 0.9415 *** (0.1828)  |
| LNEC         | 1.2391 *** (0.0385)  | 1.1974 *** (0.0571)  | 0.4617 *** (0.1412) | 0.4621 *** (0.1004)  |
| LNEXP        | −0.0905 *** (0.0327) | −0.1729 *** (0.0466) | −0.2615 ** (0.1208) | 0.1163 *** (0.0311)  |
| LNIMP        | −0.0005 (0.0390)     | 0.1762 *** (0.0541)  | 0.2683 ** (0.1307)  | 0.0240 (0.0562)      |
| LNFD         | −0.0175 *** (0.0066) | −0.0131 * (0.0068)   | 0.0706 * (0.0401)   | 0.1066 ** (0.0405)   |
| _cons        | −2.3459 ** (1.1887)  | 4.0589 * (2.0986)    | 9.0141 (12.2305)    | −31.564 *** (11.13)  |
| Hausman Test | 68.53 (0.00)         | 73.24 (0.00)         | 20.35 (0.0261)      | 34.86 (0.00)         |

Note: Figures symbolize significance at 1% (\*\*\*), 5% (\*\*) and 10% (\*); Stand. Errors are reported in ().

#### 4.6. Endogeneity Test

This study used panel data, which generally have the issue of endogeneity. Although there are several benefits of quantile regression, it is not enough to control the endogeneity issue. To control this issue, the study employed the generalized method of moments (GMM). This technique is the best technique to deal with this issue in panel data, because it has the merits to adjust coefficients [39–41]. This technique was for the first time used by Arellano and Bond [42] for panel data. This technique is also known as a dynamic model for the estimation of panel data.

The outcomes of GMM are reported in Table 8. The outcomes of this test are almost consistent with the outcomes of quantile regression. The coefficient of the urban population indicates a significant positive effect on environmental degradation at the 5% level in the lower-middle-income group of countries. GDP significantly positively affects environmental degradation at the 5% level in the lower-middle-income countries. The population is significantly negatively inclined to environmental degradation at different levels in the panel and different income-based groups. The coefficient of energy consumption indicates a significant positive effect on environmental degradation at different levels in the panel, high-income group and lower-middle-income groups of countries.

Exports are significantly negatively inclined to environmental degradation at different levels in the panel, high-income group and lower-middle-income group of countries. The coefficient of imports indicates a significant positive effect on environmental degradation at different levels in the panel, high-income group and upper-middle-income group of countries. Financial development has a significantly negative effect on environmental degradation at the 1% level in the panel and high-income group of countries.

**Table 8.** Results of Generalized Method of Moments (GMM) test.

| Variables                     | Panel                | High Income          | Upper-Middle Income | Lower-Middle Income  |
|-------------------------------|----------------------|----------------------|---------------------|----------------------|
| Lag_EDD                       | 0.1710 *** (0.0595)  | 0.0687 (0.0627)      | 0.4281 *** (0.1257) | −0.1365 (0.1618)     |
| LNEDU                         | 0.0229 (0.0783)      | 0.0986 (0.0858)      | −0.1581 (0.1728)    | −0.0072 (0.1021)     |
| LNINOV                        | −0.0058 (0.0084)     | −0.0083 (0.0107)     | 0.0054 (0.0175)     | 0.0008 (0.0103)      |
| LNUP                          | 0.0624 (0.2595)      | −0.5277 (0.3853)     | 0.5859 (0.3772)     | 1.8033 ** (0.7957)   |
| LNFDI                         | 0.0298 (0.0248)      | 0.0004 (0.0005)      | −0.2685 (0.4641)    | −0.9624 (0.6013)     |
| LNGDP                         | 0.0750 (0.0590)      | 0.0374 (0.0723)      | −0.2071 (0.1579)    | 0.2060 ** (0.0990)   |
| LNPOP                         | −0.4023 *** (0.1215) | −1.1328 *** (0.1904) | −0.2827 * (0.1601)  | −0.5347 * (0.3008)   |
| LNEC                          | 0.6594 *** (0.0712)  | 0.4245 *** (0.0984)  | 0.2328 (0.1454)     | 0.4950 *** (0.1764)  |
| LNEXP                         | −0.2369 *** (0.0634) | −0.5507 *** (0.0954) | −0.1663 (0.1647)    | −0.1388 *** (0.0522) |
| LNIMP                         | 0.2159 *** (0.0689)  | 0.5833 *** (0.1016)  | 0.3063 ** (0.1430)  | 0.0473 (0.0895)      |
| LNFD                          | −0.0879 *** (0.0220) | −0.09 *** (0.0225)   | −0.0020 (0.0441)    | −0.0849 (0.0694)     |
| _cons                         | 1.5538 (1.9736)      | 16.757 *** (3.7590)  | 6.9853 (12.2086)    | 25.1781 (17.2581)    |
| Wald Test<br>( $p > \chi^2$ ) | 492.61 (0.00)        | 505.48 (0.00)        | 103.9 (0.00)        | 296.45 (0.00)        |

Note: Figures symbolize significance at 1% (\*\*\*), 5% (\*\*) and 10% (\*); Stand. Errors are reported in ().

## 5. Conclusion and Policy Implications

This study examined the effect of education, urbanization, and green innovation on environmental degradation in the Union for Mediterranean (UFM) countries by using panel data from 2001 to 2016. The sample of the study is divided based on the income level of countries. This study followed and extended the environmental Kuznets curve (EKC) theory and ecological modernization theory (EMT). The results are estimated by using a panel co-integration test, quantile regression, ordinary least squares (OLS), fixed-effects model, and GMM model, based on the income level of countries.

The empirical results confirmed that urban population has an inverted U-shaped association with environmental degradation in the lower-middle group and high-middle group of countries, while the urban population has a U-shaped linkage with environmental degradation in the upper-middle group of countries. It implies that the lower-middle group and high-middle group of countries followed the turning path to decreasing environmental degradation through urbanization. It endorses the ecological modernization theory. The empirical outcomes showed that education decreases environmental degradation in the high-income group of countries. Moreover, the results highlighted that innovation decreases environmental degradation in the upper-middle group and high-middle group of countries. The empirical findings validated an inverted U-shaped association between GDP and environmental degradation in all income-based groups of countries; hence, it supports the EKC curve hypothesis.

The empirical outcomes showed that FDI decreases the environmental degradation in the lower-middle group of countries; however, FDI increases the environmental degradation in the upper-middle group of countries. The empirical results highlighted that population stimulates the environmental degradation in the lower-middle group and upper-middle group of countries. The empirical findings demonstrated that energy consumption stimulates environmental degradation in all income-based groups of countries. The results indicated that exports decrease environmental degradation in all income-based groups of countries. The results highlighted that imports increase environmental degradation in the upper-middle group of countries. The results showed that financial development increases environmental degradation in the lower-middle group of countries.

Based on the findings of the study, we suggest the following policy implications to secure clean environments in the UFM countries. It is suggested that UFM countries

should promote green infrastructure and industry agglomeration, especially in the upper-middle group of countries. These could be helpful to decrease the extensive usage of cement, iron, and other things, which can eventually decrease the environmental degradation. It is also important for UFM countries to shift the burden of energy from fossil fuels or non-renewable energy resources to renewable energy resources such as hydro, solar, wind, or other renewable energy projects. From the educational point of view, the UFM countries should focus on human capital and awareness of the potential of environmental quality. Human capital is directly linked with growth, and it is evident that many developed countries have shifted their production approach from labor-intensive to the human capital-oriented economy [18]. It is also considered that educated people with full awareness of environmental quality generally decrease the usage of fossil fuels and non-renewable energy resources [43].

It is also suggested that UFM countries should formulate the import structure by replacing the energy-intensive products with patent-intensive products, which will assist in decreasing the environmental degradation and promoting the technology-driven knowledge to the local industry from foreign industry. Moreover, UFM countries should improve endogenous green innovation, it will help to promote the export of value-added products and create hurdles in the exports of pollution-intensive products. Many developing countries tend to increase their profits by exporting pollution-intensive products. So, it is necessary for Mediterranean countries to control export-related environmental degradation. Furthermore, UFM countries should enforce strict environmental regulations on foreign firms to overcome FDI-related environmental degradation.

This study is limited to the Union for Mediterranean (UFM) countries. For future insight, it is expected to study more diverse samples of countries. Moreover, this study focused on four categories based on income levels such as lower-middle-income countries, upper-middle-income countries, and high-income countries. It is possible to divide the sample on more categories based on income levels in case of data availability. It could also be beneficial to analyze the sample of countries by classifying the data based on the GDP of countries.

The potential weakness of this study is to use the data for 16 years from 2001 to 2016 due to data constraints. The researchers in the future could try to find out updated data and use in their studies. Furthermore, this study is limited to highlight new determinants of environmental degradation such as green innovations, education, urbanization and some others. There are still a number of hidden determinants of environmental degradation which need to be explored in future studies.

This study used rigorous econometric techniques for analysis such as panel co-integration, panel quantile regression, GMM and others. For future studies, it is suggested to use comparatively new econometric technique- bootstrapping bounds test developed by McNown et al. [44] for analysis purposes.

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