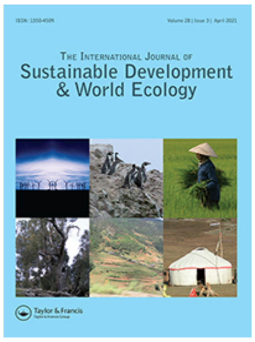

International Journal of Sustainable Development & World Ecology

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/tsdw20

Environmental sustainability in Turkey: an environmental Kuznets curve estimation for ecological footprint

Umit Bulut

To cite this article: Umit Bulut (2021) Environmental sustainability in Turkey: an environmental Kuznets curve estimation for ecological footprint, International Journal of Sustainable Development & World Ecology, 28:3, 227-237, DOI: 10.1080/13504509.2020.1793425

To link to this article: https://doi.org/10.1080/13504509.2020.1793425

INTERNATIONAL JOURNAL OF SUSTAINABLE DEVELOPMENT & WORLD ECOLOGY
2021, VOL. 28, NO. 3, 227–237
https://doi.org/10.1080/13504509.2020.1793425

Environmental sustainability in Turkey: an environmental Kuznets curve estimation for ecological footprint

Umit Bulut

Faculty of Economics and Administrative Sciences, Department of Economics, Kirsehir Ahi Evran University, Kirsehir, Turkey

ABSTRACT
The goal of this paper is to detect the determinants of ecological footprint (EF) in Turkey within the scope of the environmental Kuznets curve (EKC) hypothesis over the period 1970–2016. For this purpose, the paper sets up an empirical model including GDP, the square of GDP, foreign direct investments, renewable energy consumption, and industrialization. Hence, the paper also searches for the validity of the pollution haven hypothesis (PHH) for Turkey. The findings of the paper indicate that the EKC hypothesis prevails, whereas the PHH does not dominate in Turkey. The findings also imply EF is negatively related to renewable energy consumption while industrialization does not affect EF. Theoretical and practical implications are discussed.

ARTICLE HISTORY
Received 13 June 2020
Accepted 4 July 2020

KEYWORDS
Sustainable development; ecological footprint; environmental Kuznets curve hypothesis; pollution haven hypothesis; renewable energy; Turkey

1. Introduction

The interaction between environment and economic development has been a major research field for scientists since the Club of Rome's report titled 'Limits to Growth' and prepared by Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, and William W. Behrens III in 1972 (Meadows et al. 1972). This report denotes that the demographic pressure in the world reached a very high level as the needs of people were met by overexploiting the natural environment. The main outcomes of the report are as follows: (1) If the growth trends in world population, industrialization, pollution, and resource exhaustion remain unchanged, the limits to growth on the Earth will become apparent by 2072. (2) It is possible to change the growth trends to achieve ecological and economic stability. (3) To achieve these outcomes, people in the world should go into action right away. Then, in 1987, the report that was titled 'Our Common Future' and prepared by the United Nations made a basic definition for the concept of sustainable development. Accordingly, sustainable development means 'to meet the needs of the present without compromising the ability of future generations to meet their own needs' (United Nations 2014). Besides, this report denotes that the so-called free goods like air and water are also resources and may be scarce and that the negative effects of economic activities on the quality of air, water, and other natural elements should be minimized to achieve sustainable development. According to both reports, sustainable development is directly associated with ecological stability along with economic and social development (Güney 2019; Güney and Kantar 2020). In addition to these attention-grabbing reports, to reduce environmental problems, some meetings have been established in the last decades, such as the Rio de Janeiro Earth Summit in 1992, the Kyoto protocol in 1997–2005, and the 2015 United Nations Climate Change Conference in Paris.

Despite these efforts, environmental problems in the world have dramatically increased in the last decades. For instance, World Health Organization (2018) remarks that 7 million premature deaths occurred because of air pollution exposure in 2012 all around the world and that air pollution is the greatest environmental health risk in the world. Additionally, the Earth's average surface temperature has increased nearly 0.9°C/1.62°F since the late nineteenth century due to enhanced carbon dioxide (CO_2) and other greenhouse gas emissions (GHGs) and also the year 2016 was the hottest year as yet (NASA 2018a). These data reveal the world faces with serious global warming and climate change risks. NASA (2018b) remarks that climate change is likely to result in higher temperatures, a change in precipitation patterns, more draughts and heat waves, and more intense and stronger hurricanes.

Due to this huge environmental degradation that the world confronts, a large economic literature has examined the causes of environmental degradation (Işik et al. 2017). Put differently, the factors leading to environmental problems constitute an important part of the research agenda on environmental economics. Within this scope, the earlier studies used CO_2 emissions and/or other GHG emissions as an indicator of environmental degradation (Ulucak and Bilgili 2018; Danish et al. 2019; Danish and Khan 2020; Dogan et

CONTACT Umit Bulut ubulut@ahievran.edu.tr
Supplemental data for this article can be accessed here.

al. 2020; Zmami and Ben-Salha 2020). Yet, these variables are not able to reflect the comprehensive nature of environmental degradation (Ulucak and Apergis 2018; Ulucak and Bilgili 2018; Danish et al. 2019; Dogan et al. 2019, 2020; Danish and Khan 2020; Destek and Sinha 2020). Therefore, the recent empirical literature has used ecological footprint (EF) as a relatively new indicator for the proxy of environmental degradation and EF has become a very popular environmental degradation indicator in recent years (Ulucak and Bilgili 2018; Danish et al. 2019; Danish and Khan 2020; Destek and Sinha 2020; Dogan et al. 2020). EF which was suggested as an indicator of environmental pressure gauges human exploitation of natural capital (Wackernagel and Silverstein 2000; Bartelmus 2008). Hence, one can observe through EF that the degree to which the biological capacity of the Earth is used by human activities (Kitzes and Wackernagel 2009; Ulucak and Bilgili 2018). Activities here mean resource consumption and the production of goods and services for a population (Kitzes and Wackernagel 2009). EF signifies how much biologically productive land and water area is required for a given population to produce the resources consumed and to absorb the wastes generated by using the current technology (Wackernagel and Silverstein 2000; Bagliani et al. 2008; Bartelmus 2008; Caviglia-Harris et al. 2009; Kitzes and Wackernagel 2009). Put differently, it demonstrates the required natural capital to pursue the current production of an economy in the presence of current production executions (Wackernagel and Silverstein 2000). EF can be compared to biocapacity that is a measure of the quantity for biologically productive land and water areas, namely forest, cropland, and fishing grounds (Kitzes and Wackernagel 2009; Borucke et al. 2013). There exists an ecological deficit where EF is higher than biocapacity for a population and an ecological surplus otherwise. One may interpret ecological surplus as a precondition for sustainability while he/she may consider ecological deficit as an indicator of unsustainability (Bagliani et al. 2008; Ulucak and Bilgili 2018). A great strength of EF is that it aggregates a wide variety of environmental gauge into a single indicator, which can be handily compared to biocapacity (Costanza 2000). Hence, the public can easily understand the possible environmental sustainability problem by observing EF and biocapacity (Caviglia-Harris et al. 2009).[1]

One can observe throughout the environmental economics literature that some hypotheses are commonly tested to clarify the reasons for the environmental degradation. The first and best-known hypothesis is the environmental Kuznets curve (EKC) hypothesis. The EKC hypothesis was suggested by Grossman and Krueger (1991, 1995), who revised the original study of Kuznets (1955), focusing on income distribution and economic growth, for the relationship between environmental deterioration and economic growth. According to the EKC hypothesis, the initial process of economic growth is characterized by high energy consumption mainly met by fossil energy sources which are cheaper than renewables (Sarkodie and Strezov 2019a). For this reason, the environmental quality decreases as more sources are utilized for economic activities and many wastes and GHGs show up at this stage, i.e. the scale effect (Sun and Fang 2018; Ulucak and Bilgili 2018; Bulut 2019). Then, the economy is able to replace old and dirty technologies with new and clean technologies after income attains a turning point/threshold value (Copeland and Taylor 2003). In other words, the later stages of economic development will result in a stronger demand for green goods and environmental regulation, which in turn will lead to allocation of more sources to research and development in order to substitute fossil sources with renewable sources, i.e. the composition and technique effects (Bagliani et al. 2008; Sarkodie and Strezov 2019a). Additionally, the structure of an economy is likely to shift to technology-intensive industries and services (Ulucak and Bilgili 2018). Hence, the EKC hypothesis argues that the environmental destruction level first enhances due to economic growth and then starts to diminish after output reaches a brink, indicating an inverted U-shaped relationship between income and environmental deterioration (Dinda 2004; Stern 2004; Hao and Liu 2015; Sun and Fang 2018; Pata 2018a; Işık et al. 2019). The validity of the EKC hypothesis implies that economic growth complies with environmental progress (Dinda 2004; Su and Chen 2018).

Besides the EKC hypothesis, researchers commonly test the pollution haven hypothesis (PHH) which links environmental deterioration with foreign direct investments (FDI). The liberalization of trade and free movement of capital across countries have led to intensive FDI inflows to developing countries since the 1990s (Acharyya 2009; Hao and Liu 2015; Koçak and Şarkgüneşi 2018). Besides the positive influences of FDI to the host countries, such as the transfer of capital and technology, increases in export, improvement in the balance of payments, positive externalities, new processes, and managerial skills (Acharyya 2009; Shahbaz et al. 2015; Sarkodie and Strezov 2019b), FDI inflows to developing countries have also become an environmental issue (Mert and Bölük 2016). The PHH posits that weak environmental regulations in developing countries will attract multinational firms in terms of transferring their dirty and heavily polluting industries to developing economies as developed economies usually have more stringent environmental policies (Akbostanci et al. 2007; Seker et al. 2015; Baek 2016; Mert and Bölük 2016; Zhang and Zhou 2016; Shao et al. 2019; Sarkodie and Strezov 2019b). Therefore, developing economies will suffer from the environmental deterioration further compared to developed economies with regard to the PHH (Baek 2016; Zhang and Zhou 2016). On the other hand, the pollution halo hypothesis concentrates on better management practices and the modern and eco-friendly technologies used by the multinational firms (Jalil and Feridun 2011; Shahbaz et al. 2015; Mert and Bölük 2016; Koçak and Şarkgüneşi 2018). According to this hypothesis, FDI is likely to improve environmental quality in the host countries as multinational firms will bring their better environmental management systems and cleaner technologies that will diffuse in time (Seker et al. 2015; Shahbaz et al. 2015; Mert and Bölük 2016; Zhang and Zhou 2016).

Some other indicators are incorporated into the empirical model when investigating the validity of the EKC hypothesis. As is explained above, the EKC hypothesis postulates that the positive impact of economic growth on environmental quality emerges due to the utilization of renewable energy which can decrease environmental problems. Besides, the shift of the structure of the economy from the industrial sector to the services sector is an important factor leading to a negative relationship between environmental deterioration and economic growth as the industrial sector is more pollutant compared to the service sector. Put differently, an empirical model of which purpose is to search for the validity of the EKC hypothesis should also contain renewable energy and industrialization. For this reason, renewable energy and industrialization should be included in the EKC models to find unbiased findings (Shen 2006). For instance, while some papers consider renewable energy as a determinant of EF (Destek et al. 2018; Alola et al. 2019; Balsalobre-Lorente et al. 2019; Dogan et al. 2019; Altıntaş and Kassouri 2020; Danish and Khan 2020; Destek and Sinha 2020; Usman et al. 2020), some others examine the impact of the industrial sector on environmental quality (Shi 2003; York et al. 2003; Shen 2006; He and Richard 2010; Apergis and Ozturk 2015; Aşici and Acar 2015; Dai et al. 2018).

Based on the explanations above, this paper sets up an empirical model to detect the determinants of EF for Turkey over the period 1970–2016. The model includes output, the square of output, FDI, renewable energy consumption, and industrialization. Hence, the paper not only tests the EKC and PHH hypotheses but also examines the influences of industrialization and renewable energy consumption on EF. This paper contributes to the existing literature in four ways. *First*, Turkey has been suffering from the ecological deficit over the last decades, meaning EF is greater than biocapacity in Turkey. Therefore, detecting the determinants of EF and designing environmental policies to decrease EF are crucial within the scope of the goal of sustainable development for Turkey. *Second*, although there is an expanding empirical literature on the estimation of EKC for Turkey, a great part of the previous papers uses CO_2 emissions as the indicator of environmental degradation. Besides, the PHH seems to be ignored in the empirical literature as only a few papers search for the validity of this hypothesis for Turkey (see Table 1). Hence, there appear to be research gaps on these topics. This paper tries to fill these gaps to some degree. *Third*, most of the previous papers searching for the validity of the EKC hypothesis for Turkey do not incorporate renewable energy consumption and industrialization into the empirical models even though these variables have critical roles in the EKC hypothesis (see Table 1). Therefore, the previous papers may have suffered from the omitted variable bias. This paper avoids this possible problem by using an empirical model that includes these variables. *Fourth*, a major part of the previous papers does not check the empirical findings' robustness as they employ only one estimation technique (see Table 1). This paper first performs the autoregressive distributed lag (ARDL) approach propounded by Pesaran and Shin (1999) and Pesaran et al. (2001). Then, to control the robustness of the empirical findings, the paper employs the dynamic ordinary least squares (DOLS) estimator of Saikkonen (1991) and Stock and Watson (1993). Hence, the paper aims to provide unbiased and efficient findings. In addition, both methods can report efficient results in small samples.

The rest of the paper is organized as follows: Section 2 gives empirical literature. Model and data set are introduced in Section 3. Section 4 presents the estimation methodology. Estimation results are reported in Section 5. Section 6 concludes the paper.

2. Literature review

The empirical literature on the EKC estimation for the Turkish economy is exhibited in Table 1. As is seen from the table, a major part of the previous studies used CO_2 emissions as the indicator of the environmental degradation, while some of the recent papers (Ozcan et al. 2018; Destek and Sarkodie 2019; Dogan et al. 2019; Köksal et al. 2020) used EF. Hence, it can be argued that a great part of the previous literature on the EKC estimation for Turkey is not able to capture the broad nature of the environmental destruction. Besides, while most of the previous papers explored the EKC prevailed in Turkey, two out of four papers using EF as the environmental variable found the EKC dominated. When it comes to testing the PHH for Turkey, it is seen that only four papers examined the PHH for Turkey within the scope of the EKC hypothesis (Seker et al. 2015; Gökmenoğlu and Taspinar 2016; Koçak and Şarkgüneşi 2018). One can observe that none of these papers used EF as a proxy for environmental destruction and that three out of four papers (Seker et al. 2015; Gökmenoğlu and Taspinar 2016; Koçak and Şarkgüneşi 2018) discovered the PHH was valid in Turkey. Finally, some of the previous papers, namely Bölük and Mert (2015), Bilgili et al. (2016), Pata (2018a, 2018b), Dogan et al. (2019), Karasoy and Akçay (2019), and Uzar and

Table 1. Empirical literature on the EKC estimation for Turkey.

Author(s)	Environmental Variable	Period	Method	Covariate(s)	Finding(s)
Akbostanci et al. (2009)	CO_2	1968–2003	Johansen	No	No EKC
Halicioglu (2009)	CO_2	1960–2005	ARDL	EC, O	EKC Both covariates increase CO_2.
Ozturk and Acaravci (2013)	CO_2	1960–2007	ARDL	EC, O, FD	EKC EC and O increase CO_2. FD does not affect CO_2.
Ozcan (2013)	CO_2	1990–2008	FMOLS	EC	EKC EC increases CO_2.
Yavuz (2014)	CO_2	1960–2007	OLS, FMOLS	EC	EKC EC increases CO_2.
Bölük and Mert (2015)	CO_2	1961–2010	ARDL	EPRS	EKC EPRS decreases CO_2.
Seker et al. (2015)	CO_2	1974–2010	ARDL	FDI, EC	EKC PHH is valid. EC decreases CO_2.
Tutulmaz (2015)	CO_2	1968–2017	Engle-Granger, Johansen	No	EKC
Bilgili et al. (2016)	CO_2	1977–2010	FMOLS, DOLS	REC	Mixed findings for EKC REC decreases CO_2.
Ertugrul et al. (2016)	CO_2	1971–2011	ARDL	EC, O	EKC Both covariates increase CO_2.
Gökmenoğlu and Taspinar (2016)	CO_2	1974–2010	ARDL	EC, FDI	EKC PHH prevails. EC increases CO_2.
Gozgor and Can (2016)	CO_2	1971–2010	DOLS	EC, EPD	EKC EC increases CO_2. EPD decreases CO_2.
Ozatac et al. (2017)	CO_2	1960–2013	ARDL	EC, FD, O, U	EKC All covariates increase CO_2.
Çetin and Ecevit (2017)	CO_2	1960–2011	ARDL	EC, FD, O	EKC All covariates increase CO_2.
Katircioğlu and Taşpinar (2017)	CO_2	1960–2010	DOLS	EC, FD	EKC Both covariates increase CO_2.
Koçak and Şarkgüneşi (2018)	CO_2	1974–2013	DOLS	FDI, EC	EKC PHH dominates. EC increases CO_2.
Ozcan et al. (2018)	EF	1961–2013	Time-varying causality	No	No EKC
Pata (2018a)	CO_2	1971–2014	ARDL	FD, I, U, CC, X, M, NCEC	EKC FD, I, U, CC, and M increase CO_2. X and NCEC decrease CO_2.
Pata (2018b)	CO_2	1974–2014	ARDL, FMOLS, CCR	FD, REC, U	EKC FD and U increase CO_2. REC does not affect CO_2.
Cetin et al. (2018)	CO_2	1960–2013	ARDL	EC, FD, O	EKC All covariates increase CO_2.
Destek and Sarkodie (2019)	EF	1977–2013	AMG	EC, FD	No EKC Both covariates do not affect CO_2.
Dogan et al. (2019)	EF	1971–2013	ARDL	FEC, REC, FD, U, X, M	EKC FEC, U, and M increase CO_2. REC and X decrease CO_2. FD does not affect CO_2.

(*Continued*)

Table 1. (Continued).

Author(s)	Environmental Variable	Period	Method	Covariate(s)	Finding(s)
Karasoy and Akçay (2019)	CO_2	1965–2016	ARDL	NREC, REC, O	EKC NREC and O increase CO_2. REC decreases CO_2.
Uzar and Eyuboglu (2019)	CO_2	1984–2014	ARDL	EC, I, U, FD, O, G	EKC EC, I, O, and G increase CO_2. U and FD do not affect CO_2.
Köksal et al. (2020)	EF	1961–2014	Johansen	EC, FD, U, O, SE, EX	EKC FD, O, and SE increase CO_2. EC and EX decrease CO_2. U does not affect CO_2.

Note: AMG: augmented mean group, ARDL: autoregressive distributed lag, CC: coal consumption, CO_2: CO_2 emissions, DOLS: dynamic ordinary least squares, EC: energy consumption, EF: ecological footprint, EKC: environmental Kuznets curve, EPD: export product diversification, EPRS: electricity production from renewables, EX: exchange rate, FEC: fossil energy consumption, FD: financial development, FDI: foreign direct investments, FMOLS: fully modified ordinary least squares, G: Gini coefficient, M: import, NCEC: noncarbohydrate energy consumption, NREC: non-renewable energy consumption, O: trade openness, OLS: ordinary least squares, PHH: pollution haven hypothesis, REC: renewable energy consumption, SE: size of shadow economy, U: urbanization, X: export.

Eyuboglu (2019), utilized renewable energy and/or industrialization as the other determinants of the environmental deterioration. While Bölük and Mert (2015), Bilgili et al. (2016), Dogan et al. (2019), Karasoy and Akçay (2019) found that renewable energy improved environmental quality, Pata (2018a) and Uzar and Eyuboglu (2019) explored industrialization increased environmental destruction.

3. Model and data set

Following a time series analysis for Turkey, the present paper defines ecological footprint as a function of GDP, the square of GDP, foreign direct investments, renewable energy consumption, and industrialization. Hence, the model in this paper can be described as the following:

$$\ln EF_t = \beta_0 + \beta_1 \ln Y_t + \beta_2 (\ln Y_t)^2 + \beta_3 \ln FDI_t + \beta_4 \ln REC_t + \beta_5 \ln IND_t + \varepsilon_t \quad (1)$$

where ln, EF, Y, Y^2, FDI, REC, IND, and ε, respectively, stand for natural logarithm, real GDP per capita (constant 2010 USD), the square of real GDP per capita, foreign direct investments (net inflows, current USD), renewable energy consumption (the share of renewable energy in total final energy consumption, %), industrialization (industry (including construction), value added (% of GDP)), and the error term. Annual data covering the period 1970–2016 are used in the paper. It must be noted that the paper uses the longest publicly available data. The data for EF are extracted from the Global Footprint Network (2020). GDP, FDI, and IND data are obtained from the World Bank (2020), renewable energy data are received from the World Bank (2020) and International Energy Agency (2020).

4. Methodology

4.1. Unit root tests

Prior to estimating long-run parameters in the empirical model, the paper examines the stationarity properties of the variables in the model to avoid the possible spurious regression problem, namely inappropriate t and/or F statistics. Hence, the paper first performs some unit root tests to detect the order of integration of the variables. Accordingly, the paper first uses unit root tests of Dickey and Fuller (1981, henceforth ADF), Phillips and Perron (1988, henceforth PP), and Kwiatkowski et al. (1992, henceforth KPSS) without structural breaks. Then, the paper performs the unit root test developed by Zivot and Andrews (1992, henceforth ZA) with one break by relaxing the strong assumption of no break during the observed period. While the null hypotheses of ADF, PP, and ZA are that the series has a unit root and thus is not stationary, the null hypothesis of the KPSS tests is that the series is stationary.

Table 2. Unit root tests.

	ADF		PP		KPSS		ZA[a]	
Variable	Level	1st dif.	Level	1st dif.	Level	1st dif.	Level	1st dif.
lnEF	−0.848	−7.481[a]	−0.794	−7.475[a]	0.871[a]	0.034	−3.761 (1979)	−7.568[a]
lnY	0.442	−6.431[a]	0.473	−6.431[a]	0.887[a]	0.111	−3.237 (1979)	−6.730[a]
$(\ln Y)^2$	0.629	−6.387[a]	0.671	−6.388[a]	0.884[a]	0.141	−3.010 (1979)	−6.750[a]
lnFDI	−0.473	−9.796[a]	−0.494	−10.711[a]	0.839[a]	0.334	−4.384 (2004)	−10.216[a]
lnREC	−1.539	−7.156[a]	−1.544	−7.167[a]	0.843[a]	0.227	−1.691 (1999)	−8.888[a]
lnIND	−2.062	−6.966[a]	−2.042	−6.968[a]	0.240	0.166	−4.245 (1999)	−7.705[a]

Note: [a] Implies 1% significance.
[a]Values in parentheses show break dates.

4.2. ARDL approach to cointegration

The ARDL approach is commonly exploited in econometric analyses to consider the cointegration relationship among nonstationary variables in a model. The ARDL method has two considerable advantages over the other cointegration tests. First, this technique can be employed irrespective of whether the independent variables are stationary at level or at first difference. Second, this method can display efficient and reliable results in small samples. For this technique, the first step is to test the null hypothesis of no cointegration by way of the bounds testing method suggested by Pesaran et al. (2001). If there is cointegration, then researchers can pass to the second step. In the second step, the long-run parameters are estimated through the model propounded by Pesaran and Shin (1999). This model can be described as follows:

$$Y_t = \alpha + \sum_{i=1}^{p} \alpha_i Y_{t-i} + \sum_{i=0}^{q} \beta_i X_{t-i} + u_t \quad (2)$$

The long-run parameters can be computed using the model above. After one calculates the long-run parameters, he/she can estimate the short-run relationship in the model by way of the error correction model that is illustrated as below:

$$\Delta Y_t = \theta_0 + \theta_1 EC_{t-1} + \sum_{i=1}^{p} \delta_i \Delta Y_{t-i} + \sum_{i=0}^{q} \lambda_i \Delta X_{t-i} + u_t \quad (3)$$

The coefficient of the one-period lagged value of the error correction (θ_1) implies how much deviation in the short run is corrected in the long-run. Therefore, this coefficient must be significant and negative to confirm cointegration.

The last step is to test the stability of the coefficients through the CUSUM and CUSUM-Q tests suggested by Brown et al. (1975). When CUSUM and CUSUM-Q test statistics take part in the bounds, then it can be argued that the estimated long-run coefficients are consistent and that the findings reported by the ARDL model are efficient.

Table 3. ARDL cointegration test.

Panel A: The bounds test to search for cointegration[a]			
Test statistic		5.596[d]	
Panel B: Long-run coefficients[a]			
Variable	Coefficient	Std. error	t-statistic
lnY	11.621[c]	2.662	4.364
$(\ln Y)^2$	−0.584[c]	0.139	−4.184
lnFDI	−0.002	0.006	−0.375
lnREC	−0.175[d]	0.075	2.305
lnIND	−0.072	0.069	−1.042
Panel C: Diagnostic tests[b]			
R^2: 0.99, $\bar{R}^2$: 0,98, F-ist.: 180.323 (0.000), χ^2_{RRT}: 2.349 (0.100), χ^2_{BGSCT}: 1.696 (0.428), χ^2_{WHT}: 16.327 (0.500)			

Notes: [a] Critical values are received from Narayan (2005), who provide critical values for relatively small samples.
[a]The coefficient of the one-period lagged error correction term is found to have the value of −0.961, supporting the presence of cointegration.
[b]χ^2_{RRT}, χ^2_{BGSCT}, and χ^2_{WHT} respectively indicate Ramsey reset test, Breusch-Godfrey serial correlation test, and White heteroskedasticity test statistics. Values depicted in parentheses show prob. values.
[c]Implies 1% significance.
[d]Implies 5% significance.

4.3. DOLS estimator

Saikkonen (1991) and Stock and Watson (1993) produce the DOLS estimator to estimate long-run coefficients in an empirical model. This method is robust to the possible serial correlation and endogeneity problems. Their model incorporates independent variables together with leads and lags of differences of independent variables. The model can be exhibited as the following:

$$y_t = \beta_0 + \beta_1 t + \beta_2 x_t + \sum_{i=-q}^{p} \gamma_i \Delta x_{t+i} + \varepsilon_t \quad (4)$$

In Equation (4), y is the dependent variable, t denotes the time trend, x stands for the independent variable (s), q indicates the optimal lag length, p shows optimal lead length, Δ describes the first difference operator, and ε stands for the error term.

5. Findings

The ADF, PP, KPSS, and ZA unit root tests' results are demonstrated in Table 2. On one hand, the ADF, PP, and ZA tests indicate that all variables are stationary at first differences, meaning all variables are integrated of

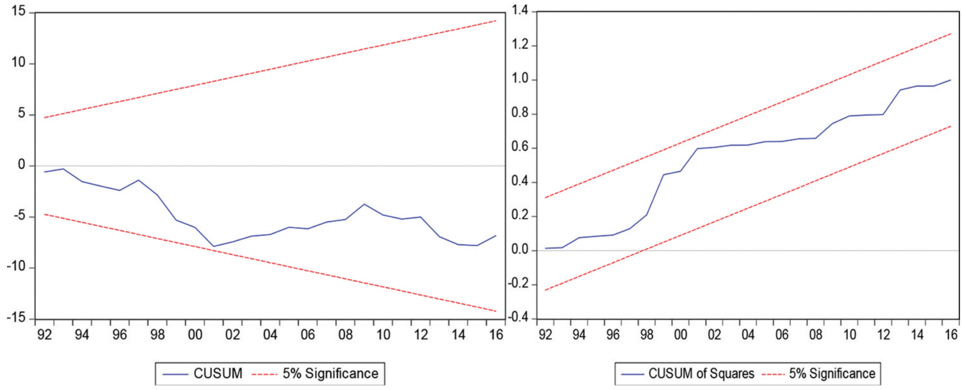

Figure 1. CUSUM and CUSUM-Q tests.

Table 4. DOLS estimator.

Variable	Coefficient	Std. error	t-statistic
lnY	6.987[a]	1.924	3.630
$(\ln Y)^2$	−0.347[a]	0.103	−3.366
lnFDI	−0.012	0.014	−0.844
lnREC	−0.241[a]	0.129	−1.860
lnIND	0.059	0.081	0.734

Notes: [a] Implies 1% statistical significance.
[a]Implies 10% statistical significance.

order one. On the other hand, the KPSS test implies lnIND is stationary at level while other variables are stationary at first differences. Hence, the ARDL method can be executed to search for the cointegration relationship in the model. Additionally, (i) the Turkish economy's transition to a neo-liberal development model may account for the breaks detected in 1979, (ii) breaks in 1999 correspond to an earthquake and economic recession period in Turkey, and (iii) high FDI inflows after the 2001 economic crisis can account the break in 2004.

Table 3 depicts the results of the ARDL cointegration test. Accordingly, the results for the bounds test are reported in panel A. As is seen, the test statistic indicates that there occurs cointegration in the empirical model and that the long-run parameters can be estimated. Panel B of the table presents the long-run coefficients of the independent variables. Accordingly, lnY, $(\ln Y)^2$, lnFDI, lnREC, and lnIND have the estimations of 11.621, −0.584, −0.002, −0.175, and −0.072, respectively. In addition, while the coefficients of lnY, $(\ln Y)^2$, and lnREC are statistically significant, other coefficients appear to be statistically insignificant. Hence, the output of the ARDL test implies that the EKC hypothesis prevails, whereas the PHH is not valid in Turkey. The ARDL method also indicates EF is negatively related to lnREC and is not related to lnIND, implying renewable energy consumption improves environmental quality while industrialization does not have any effects on the environmental destruction.

The findings of CUSUM and CUSUM-Q tests are exhibited in Figure 1. Accordingly, both CUSUM and CUSUM-Q statistics remain in the bounds throughout the observed period, implying the long-run parameters are stable over the period 1970–2016.

Finally, to check the robustness of the empirical findings, this paper employs the DOLS estimator. The findings obtained from the DOLS estimator are illustrated in Table 4. As is seen, the coefficients of lnY, $(\ln Y)^2$, lnFDI, lnREC, lnIND are 6.987, −0.347, −0.012, −0.241, and 0.059, respectively. Additionally, the coefficients of lnY, $(\ln Y)^2$, and lnREC are statistically significant, while other coefficients are statistically insignificant. Thus, the DOLS estimator yields the EKC hypothesis is valid and the PHH does not prevail in Turkey. The DOLS estimator also explores that EF is negatively associated with lnREC and is not associated with lnIND, meaning renewable energy consumption decreases environmental deterioration while industrialization does not influence environmental deterioration. Therefore, the findings of the DOLS estimator concur with those of the ARDL test, meaning the empirical findings are robust.

Overall, the empirical findings of the present paper about the EKC hypothesis conform to those of the previous papers which yield the EKC hypothesis dominates. Besides, if EF is considered as the environmental degradation, the findings of this paper concur with those of Dogan et al. (2019) and Köksal et al. (2020) and conflict with those of Ozcan et al. (2018) and Destek and Sarkodie (2019). The findings of the paper for the PHH conflict with those of the previous papers as three out of four papers discover the PHH is valid and the other paper explores the pollution halo hypothesis prevails. The findings of the paper for the influence of renewable energy on environmental destruction are consistent with those of Bölük and Mert (2015), Bilgili et al. (2016), Dogan et al. (2019), and Karasoy and Akçay (2019) and contradict with those of Pata (2018b). Finally, the output of the paper for the impact of industrialization on environmental deterioration conflict with those of Pata (2018a) and Uzar and Eyuboglu (2019), who yield industrialization decreases environmental quality.

6. Conclusion

This paper investigated whether the EKC hypothesis prevailed in Turkey using EF as the indicator of environmental destruction for the period 1970–2016. The empirical model established in the paper included FDI, renewable energy consumption, and industrialization as the control variables. Therefore, the paper also tested the PHH and examined the impacts of renewable energy consumption and industrialization on environmental degradation in Turkey. The paper first performed some unit root tests and detected the ARDL technique to cointegration could be used to search for cointegration in the empirical model. Then, the paper estimated long-run parameters through both the ARDL method and the DOLS estimator. The findings indicated that (i) the EKC hypothesis prevailed, (ii) the PHH was not valid, (iii) renewable energy consumption decreased EF, implying renewable energy could improve environmental quality, and (iv) industrialization did not influence EF.

Turkey has been stuck in an upper-middle-income level for many years, implying the Turkish economy is in the middle-income trap. Moreover, fossil energy sources still dominate the energy mix of Turkey with a share of 87% in 2016. Put differently, the share of renewable energy sources in total energy consumption was about 13% for Turkey in 2016. Therefore, the data shows that the Turkish economy has not experienced the later stages of economic development and that fossil sources have not been replaced by renewable sources in Turkey yet. The empirical findings of this paper indicate that the EKC hypothesis prevails for Turkey despite the income level and the low share of renewable sources in the energy mix of Turkey. One can argue that these findings result from the increase in the share of the services sector in GDP in Turkey as the service sector is cleaner compared to the industrial sector. While the shares of the industrial and service sector were, respectively, 21.93% and 36.28% in 1970, these ratios, respectively, increased to 29.47% and 54.26% in 2018 (World Bank 2020). These figures show that the production structure of the Turkish economy shifted from the agricultural sector to the service sector without the industrial maturation. Indeed, the insignificant coefficient of industrialization supports such a transformation of the Turkish economy. Besides, the trend and the sectoral distribution of FDI inflows towards the Turkish economy let us explain the invalidity of the PHH in Turkey. Accordingly, FDI inflows towards Turkey have increased since the early 2000s particularly because of the privatization of state-owned enterprises. Moreover, it is seen that a major part of FDI flew into the service sector. For instance, the share of the service sector in FDI inflows was about 62% during the period 2005–2019 (Central Bank of the Republic of Turkey 2020). Hence, the PHH does not prevail in Turkey as multinational firms did not transfer their dirty and heavily polluting industries to Turkey.

When one examines the renewable energy policies in Turkey, he/she can observe that these policies mainly concentrate on increasing electricity production from renewable energy sources. For instance, many legislative efforts, namely Electricity Market Law in 2001 (No: 4628), Law on Utilization of Renewable Energy Sources for the Purpose of Generating Electrical Energy in 2005 (No: 5346), and Amendments to the Electricity Market Law in 2008 (No: 5784), have been made to stimulate electricity generation from renewables (Bulut and Muratoglu 2018). Within this frame, the Turkish governments have implemented many policies towards electricity production from renewable energy sources, such as feed-in tariff scheme, incentive to promote the use of local equipment, land usage fee incentives, reinforce international electricity inter-connections (Republic of Turkey Ministry of Energy and Natural Resources 2014; Bulut and Muratoglu 2018). Due to these policies, the share of electricity generation from renewables reached 32.7% in 2018, while this ratio was 20% in 2001 (Turkish Statistical Institute 2020). Hence, one can argue that the low share of renewable energy sources in total energy consumption in Turkey arises from the underutilization of renewable energy sources in heating and transport. On the other hand, the empirical findings indicate that renewable energy increases environmental quality in Turkey despite the low share of renewable energy sources in Turkey's energy mix.

As Zhao (2019) points out, environmental regulations in developing countries can negatively affect economic growth if they are not efficient. However, these regulations can not only correct market failures (Organisation for Economic Co-operation and Development 2012) but also create resources for R&D expenditures for energy efficiency and renewable energy sources. Even though the International Energy Agency (2020) data show R&D expenditures for energy have remarkably increased in Turkey since 2013, they are still low compared to those of developed countries. Within this scope, an increase in R&D expenditures for renewable energy sources and the utilization of energy more efficiently can affect economic growth through the multiplier mechanism positively and increase environmental quality in Turkey. Last but not least, the Republic of Turkey Energy Market Regularity Authority is responsible for regulations in the energy sector in Turkey while the Republic of Turkey Ministry of Energy and Natural Resources plans future energy policies in Turkey. Hence, the coordination and harmonisation between these two institutions should increase in Turkey for more efficient legal arrangements and energy policies.

Hence, the paper argues that, for the goal of sustainable development, the Turkish government should (i) promote electricity generation from renewables further to make electricity cheaper, which in turn increases the utilization of electricity in heating, (ii) consider energy crops for the utilization of biofuels in transportation, (iii) increase R&D expenditures for energy to improve energy efficiency, and (iv) work more co-ordinately with the institution which provides the legal infrastructure for the energy sector in Turkey.

Note

1. Among others, see Ewing et al. (2010) for details about how the EF is calculated.

Disclosure statement

No potential conflict of interest was reported by the author.

References

Acharyya J. 2009. Fdi, growth and the environment: evidence from India on CO_2 emission during the last two decades. J Econ Dev. 34:43–58. doi:10.35866/caujed.2009.34.1.003.

Akbostanci E, GI T, Türüt-Aşik S. 2007. Pollution haven hypothesis and the role of dirty industries in Turkey's exports. Environ Dev Econ. 12:297–322. doi:10.1017/S1355770X06003512.

Akbostanci E, Türüt-Aşik S, Tunç GI. 2009. The relationship between income and environment in Turkey: is there an environmental Kuznets curve? Energy Policy. 37:861–867. doi:10.1016/j.enpol.2008.09.088.

Alola AA, Bekun FV, Sarkodie SA. 2019. Dynamic impact of trade policy, economic growth, fertility rate, renewable and non-renewable energy consumption on ecological footprint in Europe. Sci Tot Environ. 685:702–709. doi:10.1016/j.scitotenv.2019.05.139.

Altıntaş H, Kassouri Y. 2020. Is the environmental Kuznets Curve in Europe related to the per-capita ecological footprint or CO_2 emissions? Ecol Indic. 113:106187. doi:10.1016/j.ecolind.2020.106187.

Apergis N, Ozturk I. 2015. Testing environmental Kuznets curve hypothesis in Asian countries. Ecol Indi. 52:16–22. doi:10.1016/j.ecolind.2014.11.026.

Aşici AA, Acar S. 2015. Does income growth relocate ecological footprint? Ecol Indic. 61:707–714. doi:10.1016/j.ecolind.2015.10.022.

Baek J. 2016. A new look at the FDI-income-energy-environment nexus: dynamic panel data analysis of ASEAN. Energy Policy. 91:22–27. doi:10.1016/j.enpol.2015.12.045.

Bagliani M, Bravo G, Dalmazzone S. 2008. A consumption-based approach to environmental Kuznets curves using the ecological footprint indicator. Ecol Econ. 65:650–661. doi:10.1016/j.ecolecon.2008.01.010.

Balsalobre-Lorente D, Gokmenoglu KK, Taspinar N, Cantos-Cantos JM. 2019. An approach to the pollution haven and pollution halo hypotheses in MINT countries. Environ Sci Pollut Res. 26:23010–23026. doi:10.1007/s11356-019-05446-x.

Bartelmus P. 2008. Quantitative Eco-nomics: how sustainable are our economies? China: Springer.

Bilgili F, Koçak E, Bulut Ü. 2016. The dynamic impact of renewable energy consumption on CO_2 emissions: a revisited environmental Kuznets curve approach. Renew Sustain Energy Rev. 54:838–845. doi:10.1016/j.rser.2015.10.080.

Bölük G, Mert M. 2015. The renewable energy, growth and environmental Kuznets curve in Turkey: an ARDL approach. Renew Sustain Energy Rev. 52:587–595. doi:10.1016/j.rser.2015.07.138.

Borucke M, Moore D, Cranston G, Gracey K, Iha K, Larson J, Lazarus E, Morales JC, Wackernagel M, Galli A. 2013. Accounting for demand and supply of the biosphere's regenerative capacity: the national footprint accounts' underlying methodology and framework. Ecol Indic. 24:518–533. doi:10.1016/j.ecolind.2012.08.005.

Brown LR, Durbin J, Evans MJ. 1975. Techniques for testing the constancy of regression relationships over time. J Royal Stat Soc. 37:149–192.

Bulut U. 2019. Testing environmental Kuznets curve for the USA under a regime shift: the role of renewable energy. Environ Sci Pollut Res. 26:14562–14569. doi:10.1007/s11356-019-04835-6.

Bulut U, Muratoglu G. 2018. Renewable energy in Turkey: great potential, low but increasing utilization, and an empirical analysis on renewable energy-growth nexus. Energy Policy. 123:240–250. doi:10.1016/j.enpol.2018.08.057.

Caviglia-Harris JL, Chambers D, Kahn JR. 2009. Taking the "U" out of Kuznets. A comprehensive analysis of the EKC and environmental degradation. Ecol Econ. 68:1149–1159. doi:10.1016/j.ecolecon.2008.08.006.

Central Bank of the Republic of Turkey 2020. Electronic data delivery system. [accessed 2020 Apr 15]. https://evds2.tcmb.gov.tr/.

Çetin M, Ecevit E. 2017. The impact of financial development on carbon emissions under the structural breaks: empirical evidence from Turkish economy. Int J Econ Perspect. 11:64–78.

Cetin M, Ecevit E, Yucel AG. 2018. The impact of economic growth, energy consumption, trade openness, and financial development on carbon emissions: empirical evidence from Turkey. Environ Sci Pollut Res. 25:36589–36603. doi:10.1007/s11356-018-3526-5.

Copeland BR, Taylor MS. 2003. Trade and the environment: theory and evidence. New Jersey: Princeton University Press.

Costanza R. 2000. The dynamics of the ecological footprint concept. Ecol Econ. 32:341–345.

Dai D, Liu H, Wu J. 2018. Urbanization, energy use, and CO_2 emissions: A provincial-level analysis of China. Energy Sources Part B Econ Plan Policy. 13:205–210. doi:10.1080/15567249.2011.637543.

Danish HST, Baloch MA, Mahmood N, Zhang JW. 2019. Linking economic growth and ecological footprint through human capital and biocapacity. Sustain Cities Soc. 47:101516. doi:10.1016/j.scs.2019.101516.

Danish UR, Khan SUD. 2020. Determinants of the ecological footprint: role of renewable energy, natural resources, and urbanization. Sustain Cities Soc. 54:101996. doi:10.1016/j.scs.2019.101996.

Destek MA, Sarkodie SA. 2019. Investigation of environmental Kuznets curve for ecological footprint: the role of energy and financial development. Sci Tot Environ. 650:2483–2489. doi:10.1016/j.scitotenv.2018.10.017.

Destek MA, Sinha A. 2020. Renewable, non-renewable energy consumption, economic growth, trade openness and ecological footprint: evidence from organisation for economic Co-operation and development countries. J Clean Prod. 242:118537. doi:10.1016/j.jclepro.2019.118537.

Destek MA, Ulucak R, Dogan E. 2018. Analyzing the environmental Kuznets curve for the EU countries: the role of ecological footprint. Environ Sci Pollut Res. 25:29387–29396. doi:10.1007/s11356-018-2911-4.

Dickey DA, Fuller WA. 1981. Likelihood ratio statistics for autoregressive time series with a unit root. Econom. 49:1057–1072. doi:10.2307/1912517.
Dinda S. 2004. Environmental Kuznets Curve hypothesis: A survey. Ecol Econ. 49:431–455. doi:10.1016/j.ecolecon.2004.02.011.
Dogan E, Taspinar N, Gokmenoglu KK. 2019. Determinants of ecological footprint in MINT countries. Energy Environ. 30:1065–1086. doi:10.1177/0958305X19834279.
Dogan E, Ulucak R, Kocak E, Isik C. 2020. The use of ecological footprint in estimating the environmental Kuznets curve hypothesis for BRICST by considering cross-section dependence and heterogeneity. Sci Tot Environ. 723:138063. doi:10.1016/j.scitotenv.2020.138063.
Ertugrul HM, Cetin M, Seker F, Dogan E. 2016. The impact of trade openness on global carbon dioxide emissions: evidence from the top ten emitters among developing countries. Ecol Indic. 67:543–555. doi:10.1016/j.ecolind.2016.03.027.
Ewing B, Moore D, Goldfinger SH, Oursler A, Reed A, Wackernagel M. 2010. Ecological footprint atlas 2010. [accessed 2020 Apr 10]. https://www.footprintnetwork.org/content/images/uploads/Ecological_Footprint_Atlas_2010.pdf.
Global Footprint Network 2020. Open data platform. [accessed 2020 Apr 12]. http://data.footprintnetwork.org/#/.
Gökmenoğlu K, Taspinar N. 2016. The relationship between CO_2 emissions, energy consumption, economic growth and FDI: the case of Turkey. J Int Trade Econ Dev. 25:706–723. doi:10.1080/09638199.2015.1119876.
Gozgor G, Can M. 2016. Export product diversification and the environmental Kuznets curve: evidence from Turkey. Environ Sci Pollut Res. 23:21594–21603. doi:10.1007/s11356-016-7403-9.
Grossman GM, Krueger AB. 1991. Environmental impacts of a North American free trade agreement. NBER Work Pap. 3914.
Grossman GM, Krueger AB. 1995. Economic growth and the environment. Quart J Econ. 110:353–377. doi:10.2307/2118443.
Güney T. 2019. Renewable energy, non-renewable energy and sustainable development. Int J Sustain Dev World Ecol. 26:389–397. doi:10.1080/13504509.2019.1595214.
Güney T, Kantar K. 2020. Biomass energy consumption and sustainable development. Int J Sustain Dev World Ecol. 1–6. doi:10.1080/13504509.2020.1753124
Halicioglu F. 2009. An econometric study of CO_2 emissions, energy consumption, income and foreign trade in Turkey. Energy Policy. 37:1156–1164. doi:10.1016/j.enpol.2008.11.012.
Hao Y, Liu YM. 2015. Has the development of FDI and foreign trade contributed to China's CO_2 emissions? An empirical study with provincial panel data. Nat Hazards. 76:1079–1091. doi:10.1007/s11069-014-1534-4.
He J, Richard P. 2010. Environmental Kuznets curve for CO_2 in Canada. Ecol Econ. 69:1083–1093. doi:10.1016/j.ecolecon.2009.11.030.
International Energy Agency 2020. Data and statistics. [accessed 2020 Apr 15]. https://www.iea.org/data-and-statistics?country=WORLD&fuel=Energy%20supply&indicator=Total%20primary%20energy%20supply%20(TPES)%20by%20source.
Işik C, Kasımatı E, Ongan S. 2017. Analyzing the causalities between economic growth, financial development, international trade, tourism expenditure and/on the CO_2 emissions in Greece. Energy Sources Part B Econ Plan Policy. 12:665–673. doi:10.1080/15567249.2016.1263251.
Işık C, Ongan S, Özdemir D. 2019. Testing the EKC hypothesis for ten US states: an application of heterogeneous panel estimation method. Environ Sci Pollut Res. 26:10846–10853. doi:10.1007/s11356-019-04514-6.
Jalil A, Feridun M. 2011. The impact of growth, energy and financial development on the environment in China: A cointegration analysis. Energy Econ. 33:284–291. doi:10.1016/j.eneco.2010.10.003.
Karasoy A, Akçay S. 2019. Effects of renewable energy consumption and trade on environmental pollution: the Turkish case. Manag Environ Qual Int J. 30:437–455. doi:10.1108/MEQ-04-2018-0081.
Katircioğlu ST, Taşpinar N. 2017. Testing the moderating role of financial development in an environmental Kuznets curve: empirical evidence from Turkey. Renew Sustain Energy Rev. 68:572–586. doi:10.1016/j.rser.2016.09.127.
Kitzes J, Wackernagel M. 2009. Answers to common questions in ecological footprint accounting. Ecol Indic. 9:812–817. doi:10.1016/j.ecolind.2008.09.014.
Koçak E, Şarkgüneşi A. 2018. The impact of foreign direct investment on CO_2 emissions in Turkey: new evidence from cointegration and bootstrap causality analysis. Environ Sci Pollut Res. 25:790–804. doi:10.1007/s11356-017-0468-2.
Köksal C, Işik M, Katircioğlu S. 2020. The role of shadow economies in ecological footprint quality: empirical evidence from Turkey. Environ Sci Pollut Res. 27:13457–13466. doi:10.1007/s11356-020-07956-5.
Kuznets S. 1955. Economic growth and income inequality. Am Econ Rev. 45:1–28.
Kwiatkowski D, Phillips PCB, Schmidt P, Shin Y. 1992. Testing the null hypothesis of stationarity against the alternative of a unit root. J Econom. 54:159–178. doi:10.1016/0304-4076(92)90104-Y.
Meadows DH, Meadows DL, Randers J, Bahrens WW III. 1972. Limits to growth. [accessed 2020 Apr 1]. http://www.donellameadows.org/wp-content/userfiles/Limits-to-Growth-digital-scan-version.pdf.
Mert M, Bölük G. 2016. Do foreign direct investment and renewable energy consumption affect the CO_2 emissions? New evidence from a panel ARDL approach to Kyoto Annex countries. Environ Sci Pollut Res. 23:21669–21681. doi:10.1007/s11356-016-7413-7.
Narayan PK. 2005. The saving and investment nexus for China: evidence from cointegration tests. Appl Econ. 37:1979–1990. doi:10.1080/00036840500278103.
NASA 2018a. Climate change: how do we know? [accessed 2018 Jul 1]. https://climate.nasa.gov/evidence/.
NASA 2018b. How climate is changing? [accessed 2018 Jul 1]. https://climate.nasa.gov/effects/.
Organisation for Economic Co-operation and Development 2012. Green growth and developing countries. [accessed 2020 Jun 25]. https://www.oecd.org/greengrowth/green-development/greengrowthanddevelopingcountries-consultationdraft.htm.
Ozatac N, Gokmenoglu KK, Taspinar N. 2017. Testing the EKC hypothesis by considering trade openness, urbanization, and financial development: the case of Turkey. Environ Sci Pollut Res. 24:16690–16701. doi:10.1007/s11356-017-9317-6.
Ozcan B. 2013. The nexus between carbon emissions, energy consumption and economic growth in Middle East countries: a panel data analysis. Energy Policy. 62:1138–1147. doi:10.1016/j.enpol.2013.07.016.
Ozcan B, Apergis N, Shahbaz M. 2018. A revisit of the environmental Kuznets curve hypothesis for Turkey: new evidence from bootstrap rolling window causality. Environ Sci Pollut Res. 25:32381–32394. doi:10.1007/s11356-018-3165-x.

Ozturk I, Acaravci A. 2013. The long-run and causal analysis of energy, growth, openness and financial development on carbon emissions in Turkey. Energy Econ. 36:262–267. doi:10.1016/j.eneco.2012.08.025.

Pata UK. 2018a. The influence of coal and noncarbohydrate energy consumption on CO_2 emissions: revisiting the environmental Kuznets curve hypothesis for Turkey. Energy. 160:1115–1123. doi:10.1016/j.energy.2018.07.095.

Pata UK. 2018b. Renewable energy consumption, urbanization, financial development, income and CO_2 emissions in Turkey: testing EKC hypothesis with structural breaks. J Clean Prod. 187:770–779. doi:10.1016/j.jclepro.2018.03.236.

Pesaran MH, Shin Y 1999. An autoregressive distributed lag modelling approach to cointegration analysis. In: Strom S, editor. Econometrics and econometric theory in the 20th century: the Ragnar Frisch centennial symposium. Cambridge: Cambridge University Press. p. 371–413.

Pesaran MH, Shin Y, Smith RJ. 2001. Bounds testing approach to the analysis of level relationships. J Appl Econom. 16:289–326. doi:10.1002/jae.616.

Phillips PC, Perron P. 1988. Testing for a unit root in time series regression. Biometrika. 75:335–346. doi:10.1093/biomet/75.2.335.

Republic of Turkey Ministry of Energy and Natural Resources 2014. National renewable energy action plan for Turkey. [accessed 2020 Apr 15]. https://www.ebrd.com/news/2015/ebrd-supports-turkeys-shift-to-renewable-energy.html.

Saikkonen P. 1991. Asymptotically efficient estimation of cointegration regressions. Econom Theory. 7:1–21. doi:10.1017/S0266466600004217.

Sarkodie SA, Strezov V. 2019a. A review on environmental Kuznets curve hypothesis using bibliometric and meta-analysis. Sci Tot Environ. 649:128–145. doi:10.1016/j.scitotenv.2018.08.276.

Sarkodie SA, Strezov V. 2019b. Effect of foreign direct investments, economic development and energy consumption on greenhouse gas emissions in developing countries. Sci Tot Environ. 646:862–871. doi:10.1016/j.scitotenv.2018.07.365.

Seker F, Ertugrul HM, Cetin M. 2015. The impact of foreign direct investment on environmental quality: a bounds testing and causality analysis for Turkey. Renew Sustain Energy Rev. 52:347–356. doi:10.1016/j.rser.2015.07.118.

Shahbaz M, Nasreen S, Abbas F, Anis O. 2015. Does foreign direct investment impede environmental quality in high-, middle-, and low-income countries? Energy Econ. 51:275–287. doi:10.1016/j.eneco.2015.06.014.

Shao Q, Wang X, Zhou Q, Balogh L. 2019. Pollution haven hypothesis revisited: a comparison of the BRICS and MINT countries based on VECM approach. J Clean Prod. 227:724–738. doi:10.1016/j.jclepro.2019.04.206.

Shen J. 2006. A simultaneous estimation of environmental Kuznets curve: evidence from China. China Econ Rev. 17:383–394. doi:10.1016/j.chieco.2006.03.002.

Shi A. 2003. The impact of population pressure on global carbon dioxide emissions, 1975-1996: evidence from pooled cross-country data. Ecol Econ. 44:29–42. doi:10.1016/S0921-8009(02)00223-9.

Stern DI. 2004. The rise and fall of the environmental Kuznets curve. World Dev. 32:1419–1439. doi:10.1016/j.worlddev.2004.03.004.

Stock JH, Watson MW. 1993. A simple estimator of cointegrating vectors in higher order integrated systems. Econom. 61:783–820. doi:10.2307/2951763.

Su ECY, Chen YT. 2018. Policy or income to affect the generation of medical wastes: an application of environmental Kuznets curve by using Taiwan as an example. J Clean Prod. 188:489–496. doi:10.1016/j.jclepro.2018.04.011.

Sun S, Fang C. 2018. Water use trend analysis: A non-parametric method for the environmental Kuznets curve detection. J Clean Prod. 172:497–507. doi:10.1016/j.jclepro.2017.10.212.

Turkish Statistical Institute 2020. Main statistics. [accessed 2020 Apr 15]. http://www.turkstat.gov.tr/UstMenu.do?metod=temelist.

Tutulmaz O. 2015. Environmental Kuznets Curve time series application for Turkey: why controversial results exist for similar models? Renew Sustain Energy Revi. 50:73–81. doi:10.1016/j.rser.2015.04.184.

Ulucak R, Apergis N. 2018. Does convergence really matter for the environment? An application based on club convergence and on the ecological footprint concept for the EU countries. Environ Sci Policy. 80:21–27. doi:10.1016/j.envsci.2017.11.002.

Ulucak R, Bilgili F. 2018. A reinvestigation of EKC model by ecological footprint measurement for high, middle and low income countries. J Clean Prod. 188:144–157. doi:10.1016/j.jclepro.2018.03.191.

United Nations 2014. Report of the World Commission on Environment and Development: our Common Future. [accessed 2020 Apr 1]. https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf.

Usman O, Alola AA, Sarkodie SA. 2020. Assessment of the role of renewable energy consumption and trade policy on environmental degradation using innovation accounting: evidence from the US. Renew Energy. 150:266–277. doi:10.1016/j.renene.2019.12.151.

Uzar U, Eyuboglu K. 2019. The nexus between income inequality and CO_2 emissions in Turkey. J Clean Prod. 227:149–157. doi:10.1016/j.jclepro.2019.04.169.

Wackernagel M, Silverstein J. 2000. Big things first: focusing on the scale imperative with the ecological footprint. Ecol Econ. 32:391–394.

World Bank 2020. World bank open data. [accessed 2020 Apr 15]. https://data.worldbank.org/.

World Health Organization 2018. 7 million premature deaths annually linked to air pollution. [accessed 2018 Jun 30]. http://www.who.int/mediacentre/news/releases/2014/air-pollution/en/.

Yavuz NÇ. 2014. CO_2 Emission, energy consumption, and economic growth for Turkey: evidence from a cointegration test with a structural break. Energy Sources Part B Econ Plan Policy. 9:229–235. doi:10.1080/15567249.2011.567222.

York R, Rosa EA, Dietz T. 2003. STIRPAT, IPAT and ImPACT: analytic tools for unpacking the driving forces of environmental impacts. Ecol Econ. 46:351–365. doi:10.1016/S0921-8009(03)00188-5.

Zhang C, Zhou X. 2016. Does foreign direct investment lead to lower CO_2 emissions? Evidence from a regional analysis in China. Renew Sustain Energy Rev. 58:943–951. doi:10.1016/j.rser.2015.12.226.

Zhao J. 2019. Environmental regulation: lessons for developing economies in Asia. ADBI Work Pap Ser, 980.

Zivot E, Andrews DWK. 1992. Further evidence on the great crash, the oil-price shock, and the unit-root hypothesis. J Bus Econ Stat. 10:251–270.

Zmami M, Ben-Salha O. 2020. An empirical analysis of the determinants of CO2 emissions in GCC countries. Int J Sustain Dev World Ecol. 1-12. doi:10.1080/13504509.2020.1715508.