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The asymmetric effect eco-innovation and tourism towards carbon neutrality target in Turkey

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ABSTRACT

After the Paris Climate Conference (Conference of the Paris COP21), emerging countries also start progressing as the world has shown serious concern towards carbon neutrality targets. In doing this, the tourism and hospitality businesses have also emerged as an industry that has shown tremendous economic positive outputs and support to an economy with the lease inputs. However, tourism has also been reported to lead to increased environmental degradation as foreigners came to the host country, whereby ecological innovation emerged as a potential solution for eliminating the level of carbon emissions. In contrast, researchers are in agreement in terms of its beneficial relationship. Therefore, based on Turkey as the contextual gap and the application of quantile autoregressive distributed lag (QARDL) as the methodological contribution, the present study explores the relationship of tourism and ecological innovation within the framework of Environment Kuznets Curve (EKC) on the environment using two different proxies (carbon emissions and ecological footprint) spanning from 1995 to 2018. The results confirm the EKC curve whereby the parameter estimating tourism and ecological innovation on carbon emissions and ecological footprint, both of the integrations are found negative and statistically significant across most quantiles. Based on the findings, the study is accordingly concluded, followed by the managerial implications.

1. Introduction

There is a serious concern on the world carbon neutrality target as a regular change in the climatic conditions has raised serious concern on not just the survival of the human, but also its well-being and development, whereby it has also drastically affected the other flora and fauna (Cramer et al., 2018; Umar et al., 2021a, 2021b). In the pursuit of economic development, the human, social, and environmental aspect is often ignored by the companies at the micro-level and the countries at the macro-level (Ahmed et al., 2020; Ji et al., 2021). The overall process of economic development among the countries has been reported by (Sharif et al., 2020). In such a process, the economies used to rely on their existing natural resources at early stages as they are convenient for consumption purposes (Tao et al., 2021). With the additional consumption of natural resources to pursue economic growth and development, there is the deterioration in the natural environment which seriously devastates human well-being and other flora and fauna (Bibi et al., 2021; Umar et al., 2020). After reaching a certain level, when the economy realizes the opportunity cost that is regularly incurred to the environment, they started investing in improving productivity and intellectual capital so that the latest development to the economy is caused by the least possible expense to the environment human health.

To address this issue, there are some initiatives that international bodies have taken to improve the environment and health globally (Wang et al., 2020). For instance, in the 21st meeting addressing climatic concerns by the United Nations, "Conference of the Parties" (COP21) endorsed the Paris Agreement whereby the participants reassure the alleviate the carbon by reducing the energy consumption so that the temperature of the earth is accordingly controlled and have a continuous diminishing in carbon emissions (Zhang and Da, 2015). The

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increase in emissions is because of the many reasons, including increased pollution level, which leads to an additional level of consumption, thus producing the extra level of outputs from the existing levels and consuming extra level of resources for production' (Destek and Sarkodie, 2019). Nevertheless, there is a need for environmental protection and the preservation and conservation of the resource (Umar et al., 2020; Wang et al., 2021).

Though it seems quite logical and practical that organizations need to invest in cleaner technologies that generate a high level of productivity and have high environmental compliance, such technologies are also quite expensive, restricting organizations and their technological investments (Ahmed and Najmi, 2018; Wang et al., 2021). In addition to the investments for the latest technologies, there are few other operational alternatives. For instance, collaboration with the supply chain stakeholders (Najmi and Khan, 2017), by improving agility within (Ahmed et al., 2019b), by implementing green operational practices within operations (Ahmed et al., 2019a), and across the supply chain partners (Najmi et al., 2020) are few of the examples. It is extremely pertinent for all of these scenarios to consider that such operational improvements are impossible if the organization fails to build its innovation capabilities (Ahmed et al., 2020). At the macro or government level, the solutions are potentially the same, whereby governments need to assist where ecological innovation is not just promoted, but environmental compliance is also ensured (Ahmad et al., 2021; Su et al., 2021).

For a substantial financial betterment of an economy, the tourism and hospitality businesses have emerged as an industry that has shown tremendous economic positive outputs and support to an economy with the lease inputs (Paramati et al., 2017). There are several potential benefits which are associated with the development of the tourism industry in the host country, including contribution in employment generation, foreign investments which are being made to improve the quality of tourism, improvement in both public and private earnings through the sale of product and services and tax collection, whereby it also open several business opportunities and prospects to the entrepreneurs (Sharif et al., 2017; Su et al., 2021). However, on the other side, tourism has also been reported leading an increased level of environmental degradation as foreigners came to the host country and contributed to the additional economic activity whereby there is also an increased level of consumption of energy (Raza et al., 2017; Shi et al., 2020). According to (Peeters and Dubois, 2010), the tourism industry is reported to contribute to carbon emissions by 4.4%. Hence, even if a country pursues expanding its tourism industry, there will be an increase in environmental deterioration.

On the other hand, as already discussed, governmental institutions need to improve their level of productivity through which the consumption of the resources are safeguarded whereby this can be done by promoting a culture of research and development either solely by the government institutions or by public-private partnerships (Wang et al., 2020). Historically, the idea of innovation and knowledge integration is considered as an essence for the excellence in economic growth (Aghion and Howitt, 1990; Grossman and Helpman, 1991) whereby the ecological innovation in which innovation is being done for the preservation of the environment has been considered as an important driver of economic growth (Mensah et al., 2018). In addition to this, the exploration of ecological innovation as a potential solution for eliminating the level of carbon emissions has recently gained intense attention (Murad et al., 2019), whereby researchers are found to be in agreement in terms of their beneficial relationships (Balsalobre-Lorente et al., 2019; Shahbaz et al., 2020).

Turkey is a country that possesses an important geographical location as it connects Asia with Europe. In addition to this, this country has shown a rapid increase in tourists' visits, whereby the country has reported to be at 6th place in terms of the most visited country in 2019. In addition to this, the country possesses some fine natural sites and sceneries that attract people from all over the world, and such tourism has contributed to the country's GDP by USD 35.5 billion in 2020, which though has decreased due to COVID by 54% while comparing with 2019 in which it was reported to be USD 77.68 billion. Furthermore, the same sector has also contributed to employment generation as in 2020, the direct jobs created through this sector is 2189,500 jobs, whereas, on the whole, it has created around 272 million jobs (World Travel and Tourism Council, WTTC, 2021). On the other hand, the country is also reported to be one of the highest carbon emitters (Acaravci and Ozturk, 2010). Precisely, the country has shown an increase by 416% in 2014 while comparing the level of emissions from 1960 (Bank, 2017), which itself rings alarming bells for the country. Hence the present study is based on the indicators from Turkey as the aforementioned facts signify the country's selection for the research.

To estimate the relationship among the focused variables, the present study has employed the quantile autoregressive distributed lag (QARDL) technique, which is recently proposed by (Cho et al., 2015). The selection of this technique is based on several reasons, including the capability to capture local symmetries of the independent variable at a particular place of the dependent variable, the ability to ascertain relationships for both longer and shorter periods whereby the parameters and dynamics are evaluated at a particular place of quantile (Wang et al., 2021). Above all, the most important reason behind the selection of QARDL to be applied in the present study is that the conventional integration evaluating techniques, including linear ARDL, etc., gauged the cointegration at a single level the dependent variable(s). In contrast, QARDL can also capture the non-linear across the different levels of the dependent variable(s).

In addition to the methodological contribution, the present study also contributes by expanding the existing literature on tourism and environment pollution by exploring the geographical context of Turkey spanning from 1995 to 2018, which is rapidly showing an increase in the level of tourism. In contrast, such an increase is also igniting the level of pollution. Moreover, the present study also aims to evaluate the Environment Kuznets Curve (EKC) presence in Turkey precisely, which will also help the policymakers achieve the equilibrium between growth and pollution by integrating tourism and innovation. Hence, based on the aforementioned discussion regarding the selection of Turkey as the contextual gap and the application of QARDL as the methodological contribution, the present study explores the relationship of tourism and ecological innovation within the framework of the EKC (discussed in the subsequent sections) on the environment. The arrangement of the study is: the next section discusses the literature review, followed by the detailed discussion on the QARDL, then the estimations and results are generated on which the study is accordingly concluded, followed by the managerial implications.

2. Review of related literature

2.1. Theoretical background

Environment Kuznets Curve (EKC), which is originally proposed by (Grossman and Krueger, 1991), is a concept according to which the relationship between environment and economic growth is U-shaped invested, which means that when there is an increase in the economic output, it will also lead to the deterioration of the environment whereby after reaching to a certain level, such relationship behaves inversely and with an additional economic output there will be an improvement in the environment as well. Since its conception, this framework has been studied as a nexus across different contextual settings for studying different phenomena, even with the different proxies measuring similar phenomena (Hao et al., 2018; Shafik and Bandyopadhyay, 1992; Sharif et al., 2020). For instance, among the countries belongs to the EU (Kasman and Duman, 2015), and (Adedoyin et al., 2021) confirms the presence of the EKC for all of the EU countries, and (Nosheen et al., 2021) confirms for Asian countries, whereas the findings from the study of (Al-Mulali et al., 2016) have reported its presence in the context of

Kenya.

In addition to this, the integration of EKC has been done with other economic indicators, including research and development (Aggeri, 1999; Churchill et al., 2019), population (Akbostancı et al., 2009), and energy (Acaravci and Ozturk, 2010) are some of the examples. Such expansion of empirical findings also leads to different and contrasting evidence even in the same geographical settings. For instance, in the case of Turkey, some studies consider and validate the presence of EKC (Gozgor and Can, 2016; Saatci and Dumrul, 2012). However, there are also studies according to which EKC the argument of the presence of EKC is nullified (Acaravci and Ozturk, 2010; Koçak, 2014).

2.2. Tourism and environment deterioration

Tourism is reported as an important determinant for economic development, whereby it has also been reported as the cause to increase Environment Deterioration (Eyuboglu and Uzar, 2020; Solarin, 2014). Such relationships have been explored across different countries. For instance (Durbarry and Seetanah, 2015), conducted research whereby the role of the arrival of tourists was studied by applying the ARDL technique in Mauritius, which reported a direct relationship with carbon emissions. In the context of China, the study by (He et al., 2020) criticizes the level of energy efficiency for the tourism sector and highlights similar findings across the 30 regions of the country. The other geographical examples include Pakistan (Sharif et al., 2017), Malaysia (Solarin, 2014), and United States (Raza et al., 2017).

For Turkey, tourism is also reported to lead to an additional level of environmental pollution. However, the nature of the relationships depends on the proxy used to measure the phenomena. For instance, a positive relationship was reported (Katircioglu, 2014), but it appears negative relationships for tourism revenues (Tugcu and Topcu, 2018). Findings from the study by Zaman et al. (2017) reported the positive relationships between payments and receipts made by the tourists with GDP and environmental deterioration. In contrast, in terms of magnitude, developed countries are reported to have higher environmental deterioration through tourism while comparing with developing countries (León et al., 2014). More recently, in the context of the Asian region (Nosheen et al., 2021); and in the context of the EU, (Adedoyin et al., 2021); also reported the positive relationship between the two, which also confirms the findings of (Chen et al., 2016) and (Dogan and Aslan, 2017), whereas (Chishti et al., 2020a) reported a decrease in the long run in the context of Sri Lanka and Nepal but remained increasing effect in the context of countries of sub-continent. Nevertheless, irrespective of the selection of different proxies, the findings have reported similar meanings, but different policy implications are drawn because of the change in the proxy. Therefore, it is assumed that:

H1: Tourism has a significant impact on Environment Deterioration.

2.3. Ecological innovation and environment deterioration

Sustainability, along with its broad scope, covers three aspects as per Triple Bottom Line theorists. These include social, environmental, and economical, whereby achieving any of them is impossible without integrating the innovation across the operations (Ahmed et al., 2020). Because of the continuous adverse effects on the environment, ecological innovation has been termed a panacea to address the said problem by various researchers (Díaz-García et al., 2015; Mensah et al., 2018; Su and Moaniba, 2017). Precisely, through empirical analysis, various researchers have reported ecological innovation as a solution across different countries like United States (Solarin and Bello, 2020), China ((Zhang et al., 2017), and panel datasets like the next 11 countries (Sinha et al., 2020) and G7 countries (Ding et al., 2021). However, contrasting findings from the study of (Usman and Hammar, 2021) in the context of the APEC panel have raised the ambiguity as it was reported to have a negative relationship.

In addition to this, the contribution of innovation in alleviating environmental pollution is found in the context of developed countries. However (Ganda, 2019), reported that since the developing countries are heavily reliant on non-renewable energy sources, innovation in such countries leads to further pollution. In contrast (Bai et al., 2020), reported similar but insignificant results for countries having low incomes. On the other hand, the positive relationship of innovation for environment alleviation has been reported by numerous researchers (Gao et al., 2018; Godil et al., 2021; Miao et al., 2017). Precisely, in the context of Turkey, innovation has been reported as an important determinant for improving environmental well-being (Shan et al., 2021) as the country has started investing in cleaner technologies like electric vehicles (Sohag et al., 2019), whereas, through such initiatives, an improvement is also expected in their green growth (Ulubeyli and Kazanci, 2018). Nevertheless, the dissimilar findings urge the further exploration of the said relationships across different geographical contexts.

H2: Ecological Innovation has a significant impact on Environment Deterioration.

3. Methodology and data

For understanding the relationships among the studied variables in the context of Turkey, the relatively newly proposed model named quantile autoregressive distributed lag (QARDL) is applied. This technique has been proposed by (Cho et al., 2015), which enables the exploration of equilibrium in a more extended period of time among the predictors and the quantiles of the criterion variable. The selection of this technique is based on several reasons, including the capability to capture local symmetries of the independent variable at a particular place of the dependent variable, the ability to ascertain relationships for both longer and shorter periods of time whereby the parameters and dynamics are evaluated at a particular place of quantile. Above all, the most important reason behind the selection of QARDL to be applied in the present study is that the conventional integration evaluating techniques, including linear ARDL, etc., gauged the cointegration at a single level the dependent variable(s). In contrast, QARDL can also capture the non-linear across the different levels of the dependent variable(s).

Moreover, according to (Cho et al., 2015), the QARDL and its methodology also address the possible endogeneity concerns and accordingly address it while estimating results (for further discussion, refer to (Cho et al., 2015). Hence based on the strengths, the selection of QARDL was made and applied in the present study. In addition to this, an application of the Wald test is intended to evaluate the relationship across the time variation, enabling the uniformity of the coefficients integration throughout the quantiles. The conventional ARDL equation is mention as equation (1).

$$EN_t = \alpha + \sum_{i=1}^{p} \phi_i EN_{t-i} + \sum_{i=0}^{q_1} \gamma_i GDP_{t-i} + \sum_{i=0}^{q_2} \omega_i GDP^2{}_{t-i} + \sum_{i=0}^{q_3} \theta_i TOR_{t-i} + \sum_{i=0}^{q_4} \psi_i ECO_{t-i} + \varepsilon_t \quad (1)$$

Referring to equation (1), the error term has been referred to by ε_t, which is the explanation of $EN_t - E[EN_t / F_{t-1}]$ and the representation of minimum σ-field of $\{EN_t, GDP_t, GDP^2{}_t, TOR_t, ECO_t, EN_{t-1}, GDP_{t-1}, GDP^2{}_{t-1}, TOR_{t-1}, ECO_{t-1}\}$. In addition to this, the Schwarz Information Criterion (SIC) and its respective lag order are referred p, q_1, q_2, q_3, and q_4. Moreover, EN_t, TOR_t, ECO_t The representation of the logarithm form of Environment (which in the present study is measured by two different proxies: carbon emissions and ecological footprint), tourism, and ecological innovation. In contrast, the present study has also employed Environment Kuznets Curve. Therefore, GDP and its square have been taken, which represents the gross domestic product of Turkey.

The extension made by (Cho et al., 2015) in order to comply with the scenario involving quantiles is done in equation (1) and represented in equation (2).

$$QEN_t = \alpha(\tau) + \sum_{i=1}^{p}\phi_i(\tau)EN_{t-i} + \sum_{i=0}^{q_1}\rho_i(\tau)GDP_{t-i} + \sum_{i=0}^{q_2}\omega_i(\tau)GDP^2{}_{t-i} + \sum_{i=0}^{q_3}\theta_i(\tau)TOR_{t-i} + \sum_{i=0}^{q_4}\psi_i(\tau)ECO_{t-i} + \varepsilon_t(\tau) \quad (2)$$

In equation (2), the error term in the quantiles can further be expressed as $\varepsilon_t(\tau) = EN_t - Q_{ENt}(\tau/F_{t-1})$ whereby the τ^{th} quantile is the $Q_{ENt}(\tau/F_{t-1})$ which is the conditional EN_t on the data F_{t-1} as discussed (Kim and White, 2003). For the analysis of QARDL, the reformulation of equation (2) is shown in equation (3).

$$QEN_t = \alpha(\tau) + \sum_{i=0}^{q_1-1}\delta_{GDP_i}(\tau)\Delta GDP_{t-1} + \gamma_{GDP}(\tau)GDP_t + \sum_{i=0}^{q_2}\delta_{GDP_i^2}(\tau)\Delta GDP^2{}_{t-1} + \gamma_{GDP^2}(\tau)GDP^2{}_t + \sum_{i=0}^{q_3-1}\delta_{TOR_i}(\tau)\Delta TOR_{t-1} + \gamma_{TOR}(\tau)TOR_t + \sum_{i=0}^{q_4-1}\delta_{ECO_i}(\tau)\Delta ECO_{t-1} + \gamma_{ECO}(\tau)ECO_t + \psi_t(\tau) \quad (3)$$

Referring to equation (3), where

$$\gamma_{GDP} = \sum_{i=0}^{q_1}\rho_i(\tau),\ \delta_{GDPt}(\tau) = -\sum_{j=i+1}^{q_1}\rho_i(\tau), \gamma_{GDP^2} = \sum_{i=0}^{q_2}\omega_i(\tau),\ \delta_{GDP^2t}(\tau) = -\sum_{j=i+1}^{q_2}\omega_i(\tau), \gamma_{TOR} = \sum_{i=0}^{q_3}\theta_i(\tau),\ \delta_{TORt}(\tau) = -\sum_{j=i+1}^{q_3}\theta_i(\tau),\ \gamma_{ECO} = \sum_{i=0}^{q_4}\psi_i(\tau),\ \delta_{ECOt}(\tau) = -\sum_{j=i+1}^{q_4}\psi_i(\tau).$$

The short-run dynamics are quantified by the parameters shown in equation (3) whereby for estimating the relationships in the longer period of time between tourism and environment, equation (3) has been restructured and shown in equation (4).

$$QEN_t = \mu(\tau) + X_t'\beta(\tau) + M_t(\tau) \quad (4)$$

whereby $X = [TOR,\ GDP,\ GDP^2,\ ECO]$ and $\beta_{TOR}(\tau) = \gamma_{TOR}(\tau)[1 - \sum_{i=1}^{p}\phi_{TORi}(\tau)]^{-1}$ and $M_t(\tau) = \sum_{j=0}^{\infty}\partial_{TORj}(\tau)\Delta TOR_{t-1} + \sum_{j=0}^{\infty}\theta_{TORj}(\tau)\Delta\varepsilon_{t-1}$, with $\mu(\tau) = \alpha(\tau)[1 - \sum_{i=1}^{p}\phi_i(\tau)]^{-1}$ and $\partial_j(\tau) = \sum_{l=j+1}^{\infty}\pi_l(\tau)$. $\beta_{GDP}(\tau)$, $\beta_{GDP^2}(\tau)$ and $\beta_{ECO}(\tau)$ are estimated similarly.

$\{\theta_0(\tau),\ \theta_1(\tau),\ \ldots\ldots$ and $\{\pi_0(\tau),\ \pi_1(\tau),\ldots\ldots$ has been explained in a way that $\sum_{i=0}^{\infty}\theta_0(\tau)L^i = (1 - \sum_{i=1}^{p}\phi_i(\tau)L^i)^{-1}$ and. $\sum_{i=0}^{\infty}\pi_i(\tau)L^i = (1-L)^{-1}\left(\frac{\sum_{i=0}^{q_1}\omega_i(\tau)L^i}{1-\sum_{i=1}^{q_1}\omega_i(\tau)L^i} - \frac{\sum_{i=0}^{q_1}\omega_i(\tau)}{1-\sum_{i=0}^{q_1}\omega_i(\tau)}\right)$.

In addition to this, to avoid the serial correlation for the error term, which could lead to inferior results, the QARDL has been generalized as mentioned in equation (5).

$$Q_{\Delta EN_t} = \alpha + \rho EN_{t-1} + \phi_{GDP}GDP_{t-1} + \phi_{GDP^2}GDP^2{}_{t-1} + \phi_{TOR}TOR_{t-1} + \phi_{ECO}ECO_{t-1} + \sum_{i=1}^{p}\phi_i\Delta EN_{t-i} + \sum_{i=0}^{q_1-1}\rho_i\Delta GDP_{t-i} + \sum_{i=0}^{q_2-1}\omega_i\Delta GDP^2{}_{t-i} + \sum_{i=0}^{q_3-1}\theta_i\Delta TOR_{t-i} + \sum_{i=0}^{q_4-1}\psi_i\Delta ECO_{t-i} + V_t(\tau) \quad (5)$$

Considering equation (5), it should be noted that there is the possibility of simultaneous correlations among the coefficients which are V_t, $\Delta ECO, \Delta TOR, \Delta GDP^2$ *and* ΔGDP. Hence, the earlier associations can be evaded and countered by the application of prediction of V_t on the other coefficients, which are $\Delta ECO, \Delta TOR, \Delta GDP^2$ *and* ΔGDP, so it will be termed as $V_t = \gamma_{GDP}\Delta GDP_t + \gamma_{GDP^2}\Delta GDP^2{}_t + \gamma_{TOR}\Delta TOR_t + \gamma_{ECO}\Delta ECO_t + \varepsilon_t$. With the help of this process, the outcome of ε_t will not be associated and related to ΔECO, ΔTOR, ΔGDP^2 *and* ΔGDP. Therefore, by incorporating this error correction in equation (5), the QARDL-ECM, which is in the quantile regression-based model in its generalized form, will be represented as equation (6).

$$Q_{\Delta EN_t} = \alpha(\tau) + \rho(\tau)\big((EN_{t-1} - \beta_{GDP}(\tau)GDP_{t-1} - \beta_{GDP^2}GDP^2{}_{t-i} - \beta_{TOR}TOR_{t-1} - \beta_{ECO}ECO_{t-1}\big) + \sum_{i=1}^{p-1}\phi_i(\tau)\Delta EN_{t-i} + \sum_{i=0}^{q_1-1}\rho_i(\tau)\Delta GDP_{t-i} + \sum_{i=0}^{q_2-1}\omega_i(\tau)\Delta GDP^2{}_{t-i} + \sum_{i=0}^{q_3-1}\theta_i(\tau)\Delta TOR_{t-i} + \sum_{i=0}^{q_4-1}\psi_i(\tau)\Delta ECO_{t-i} + \varepsilon_t(\tau) \quad (6)$$

The aggregated influence of environment proxies at an earlier stage on recent environment proxies on a shorter period of time is assessed by $\phi_* = \sum_{j=1}^{p-1}\phi_j$, whereas the aggregated influence of earlier stage on the recent stage of proxies reflecting gross domestic product, GDP square, tourism, and ecological innovation on a shorter period of time is accordingly assessed by $\rho_* = \sum_{j=1}^{q_1-1}\rho_i$, $\omega_* = \sum_{j=1}^{q_2-1}\omega_j, \theta_* = \sum_{j=1}^{q_3-1}\theta_j$ *and* $\psi_* = \sum_{j=1}^{q_4-1}\psi_j$. On the other hand, the parameters gauging integration for a longer period of time for gross domestic product, GDP square, tourism, and ecological innovation is accordingly assessed by $\beta_{GDP_*} = -\frac{\phi_{GDP}}{\rho}$, $\beta_{GDP^2{}_*} = -\frac{\phi_{GDP^2}}{\rho}, \beta_{TOR_*} = -\frac{\phi_{TOR}}{\rho}$, *and* $\beta_{ECO_*} = -\frac{\phi_{ECO}}{\rho}$. Furthermore, the delta method is utilized to estimate the aggregate parameters in a shorter time and parameters gauging integration for a longer time. In this scenario, it is essential to note that the parameter ρ, which reflects the ECM, in addition to being negative, should also be statistically significant.

On the other hand, to explore the nature of the relationship in terms of linearity, symmetries, and statistical significance, for independent variables on dependent variables in both a longer and shorter period, the Wald Test has been utilized. This test is based on the distribution of Chi-square, which is accordingly applied to investigate the null and alternate hypothesis for the parameters belongs to both longer and shorter periods of time, including ω_*, ϕ_*, ρ_* and β_*, which are shown below:

$H_0^{\phi} : F\phi_*(\tau) = f\ versus H_1^{\phi} : F\phi_*(\tau) \neq f$

$H_0^{\phi} : S\omega_*(\tau) = s\ versus H_1^{\phi} : S\omega_*(\tau) \neq s$

$H_0^{\phi} : S\beta_{i*}(\tau) = s\ versus H_1^{\phi} : S\beta_{i*}(\tau) \neq s$

$H_0^{\phi} : S\rho_*(\tau) = s\ versus H_1^{\phi} : S\rho_*(\tau) \neq s$

In the aforementioned hypotheses, h*ps and h*1 are the matrices that are pre-specified and represented by F and *f*, the other pre-specified matrices, which are h*s, and h*1 is represented by S and s, whereas the restrictions and their respective numbers are represented by *h* (Cho et al., 2015). Moreover, the variables studied are represented by *i*. precisely, the application of Wald's Test was done to evaluate the linearities that are non-linear in nature, in the parameters that are adjusts and integrates. Furthermore, for every parameter, four tests were performed and four different levels. For instance, for the null hypothesis evaluation of parameter ρ_*, $H_0: \rho_*(0.05) = \rho_*(0.10) = \rho_*(0.20) = \rho_*(0.30) = \ldots = \rho_*(0.90) = \rho_*(0.95)$ whereas the alternate hypothesis is $H_a: \exists i \backslash \rho_*(i) \neq \rho_*(j)$ with $i,j \in \{0.05, 0.10, 0.20, \ldots, 0.85, 0.90, 0.95\}$ and $i \neq j$. Similarly, the evaluation of the same hypothesis was done on the other coefficients parameters, which are $\beta_{GDp}, \beta_{GDP^2}, \beta_{TOR}$ and β_{ECO} and their respective parameter in a shorter period of time which are ϕ_*, ω_*, θ_* and ψ_*.

Considering the data, all of the indicators in the present study have been taken from the database of the World Bank. Moreover, since the present study is based on a single country, only Turkey's data were extracted, which is yearly observations from 1995 to 2018.

4. Estimations and results

In the continuation of meeting the objective of the present study, in which the effects of tourism and ecological innovation was evaluated on carbon emissions and ecological footprint, within the framework of EKC by the application of QARDL for the country of Turkey, the descriptive statistics of the studied variables are shown in Table 1. The results summarized show that CE has a mean of 4.001 with a standard deviation of 0.651, whereas the minimum and maximum values are 3.151 and 5.201 respectively, whereas EFP has a mean of 0.957 with the standard deviation of 0.828, whereas the minimum and maximum values are 0.789 and 1.112 respectively. Considering the GDP, it has a mean of 3.147 with a standard deviation of 1.025, whereas the minimum and maximum values are 2.011 and 4.011, respectively, whereas GDP^2 has the mean of 4.753 with the standard deviation of 1.243, whereas the minimum and maximum values are 1.159 and 5.102 respectively. Lastly, considering the main independent variables, ECO has a mean of 2.147 with the standard deviation of 0.365, whereas the minimum and maximum values are 1.011 and 3.011, respectively, whereas TOR has a mean of 5.001 with a standard deviation of 1.111. In contrast, the minimum and maximum values are 4.151 and 6.201, respectively.

In addition to the above statistics, the normality of the variables was also evaluated by applying Jarque-Bera Stats. As per the hypothesis of this test, if the value is statistically significant, then the variable is said to be not coming from the normal distribution. Such a situation is feasible for applying techniques like QARDL as it enables the quantiles to reflect variation because of the heterogeneity across the quantiles. In the present study, the results of the Jarque-Bera Stats for all of the variables are found to be statistically significant at a 1% level of significance. The results of the descriptive and Jarque-Bera Stats are summarized in Table 1.

In the next stage, the stationary of the variables was assessed with the help of two tests which are the (Zivot and Andrews, 2002) (ZA) and "Augmented Dickey-Fuller (ADF)" test. The ZA test is preferred among the other related tests because of the apprehending of the structural breaks. Nevertheless, the application of both tests reported the confirmation of the property of stationary in both variables at 1st difference. Such kind of outcome is the clearance of the application of QARDL as the data sets have been reported to have structural breaks. The results are summarized in Table 2.

Table 1
Results of descriptive statistics.

Variables	Mean	Min.	Max.	Std. Dev.	J-B Stats
CE	4.001	3.151	5.201	0.651	16.051***
EFP	0.957	0.789	1.112	0.828	19.742***
ECO	2.147	1.011	3.011	0.365	15.313***
TOR	5.001	4.151	6.201	1.111	17.461***
GDP	3.147	2.011	4.011	1.025	20.830***
GDP^2	4.753	1.159	5.102	1.243	18.951***

Note: The asterisk ***, ** and * represent level of significance at 1%, 5% and 10% respectively.

Table 2
Results of Traditional and Structural Break Unit root test.

Variables	ADF (Level)	ADF (Δ)	ZA (Level)	Break Year	ZA (Δ)	Break Year
CE	−1.343	−5.135***	−1.351	2003 Q2	−9.330***	2006 Q1
EFP	−0.365	−3.013***	−0.852	2015 Q4	−11.330***	2011 Q2
ECO	−1.268	−6.024***	−1.271	2011 Q1	−10.330***	2008 Q4
TOR	−0.482	−4.228***	−0.222	2009 Q1	−7.413***	2000 Q1
GDP	−0.035	−5.992***	−0.239	2008 Q4	−6.046***	2017 Q1
GDP2	−1.016	−6.556***	−0.753	2016 Q1	−8.551***	2006 Q4

Note: The values in the table specify statistical values of the ADF and ZA tests. The asterisk ***, **, and * represent the significance level at 1%, 5%, and 10%, respectively.
Source: Author Estimation.

Now since the dataset meets the initial quality parameters, therefore QARDL was accordingly applied. The results of the QARDL are shown in Table 3 for CE and in Table 4 for ECF. Considering Table 3, most of the ECM terms represented by "ρ*" are statistically significant and negative, which is the initial requirement of the application of QARDL. By its value, there was confirmation of the revision. There is an existence of equilibrium among the variables in a longer period of time. For evaluating the EKC hypothesis, the parameter that estimates the GDP on CE is positive, reflecting an upward and direct relationship. This means the higher level of GDP leads to a higher level of CE. On the other hand, the parameter that estimates the GDP2 on CE was negative, reflecting a downward and inverse relationship. This means the higher level of GDP^2 leads to a lower level of CE. Statistically, it reflects an upward direction at GDP state, and then there is the downward direction, reflecting a typical inverted U-shaped hyperbola curve. This result is the confirmation of the EKC curve, which states that when an economy of a country performs, it leads to a higher level of environmental deterioration but as soon as it becomes financially stable, it started investing in seek of productivity and efficiency, which leads to the resource optimization and eventually decrease the level of environment deterioration which as per Table 3 is measured through CE (see Table 5).

On the other hand, the parameter estimating tourism on CE and ECO on CE, both of the integrations are found negative in which tourism was found to be negative and statistically significant across all of the quantiles, whereas ECO were found to be negative and statistically significant among few of the quantiles. Considering tourism, the significance and negative reflect that the higher level of tourism leads to lower CE, but this is at the initial quantiles, and on the later quantiles, the relationships become insignificant. They are considering the ecological innovation that was reported significant and negative across all of the quantiles in the reflection that CE can be eliminated through ecological innovation, which is a good direction for Turkey to pursue eliminating the level of CE from their operations. Similarly, the results of the short run are quite similar to the results of the long run. The overall results are summarized in Table 3.

For ECF. Considering Table 4, all of the ECM terms represented by "**ρ***" are statistically significant and negative, which is the initial requirement of the application of QARDL. By its value, there was a

Table 3
'Results of quantile autoregressive distributed lag (QARDL) for carbon emission.

Quantiles (τ)	Constant	ECM	Long-Run Estimates				Short-Run Estimates					
	$\alpha_*(\tau)$	$\rho_*(\tau)$	$\beta_{ECO}(\tau)$	$\beta_{TOR}(\tau)$	$\beta_{GDP}(\tau)$	$\beta_{GDP2}(\tau)$	$\phi_1(\tau)$	$\omega_0(\tau)$	$\lambda_0(\tau)$	$\theta_0(\tau)$	$\acute{\epsilon}_0(\tau)$	$\acute{\epsilon}_1(\tau)$
0.05	0.006	−0.131**	−0.154**	−0.341***	0.216*	−0.140***	0.490**	−0.050**	−0.020**	0.111***	−0.035***	−0.012
	(0.010)	(−2.148)	(−2.101)	(−2.991)	(1.762)	(−3.120)	(2.980)	(−2.140)	(−2.127)	(3.161)	(−3.000)	(−0.003)
0.10	0.013	−0.122**	−0.178**	−0.350***	0.224*	−0.147***	0.479**	−0.062*	−0.027**	0.118***	−0.039***	−0.018
	(0.005)	(−2.060)	(−2.248)	(−3.000)	(1.773)	(−3.249)	(2.961)	(−1.852)	(−2.122)	(3.152)	(−2.999)	(−0.005)
0.20	0.015	−0.137*	−0.268**	−0.321***	0.221**	−0.135***	0.488**	−0.057*	−0.026**	0.123***	−0.043**	−0.022
	(0.012)	(−1.957)	(−2.112)	(−2.992)	(2.165)	(−3.058)	(2.985)	(−1.641)	(−2.128)	(3.163)	(−2.990)	(−0.008)
0.30	0.010	−0.126**	−0.245**	−0.310***	0.229**	−0.142*	0.469**	−0.049*	−0.026	0.117***	−0.037**	−0.016
	(0.007)	(−1.969)	(−2.307)	(−3.015)	(2.370)	(−1.740)	(2.970)	(−1.648)	(−1.220)	(3.250)	(−2.980)	(−0.004)
0.40	0.016	−0.129*	−0.256**	−0.318***	0.232*	−0.150	0.481**	−0.060	−0.012	−0.122	−0.020**	−0.027
	(0.011)	(−1.737)	(−2.600)	(−3.021)	(1.871)	(−1.638)	(2.959)	(−1.047)	(−1.330)	(1.038)	(−2.989)	(−0.010)
0.50	0.022	−0.132*	−0.261**	−0.328***	0.241*	−0.141	0.429**	−0.075	−0.020	0.130	−0.033**	−0.029
	(0.013)	(−1.720)	(−2.004)	(−3.035)	(1.669)	(−1.551)	(2.989)	(−1.031)	(−1.026)	(1.149)	(−1.999)	(−0.007)
0.60	0.026	−0.121*	−0.142	−0.320***	0.231*	−0.156	0.378***	−0.059	−0.016	0.138	−0.028**	−0.023
	(0.009)	(−1.699)	(−1.313)	(−2.998)	(1.685)	(−1.469)	(2.993)	(−0.829)	(−1.116)	(0.957)	(−1.990)	(−0.011)
0.70	0.021	−0.139	−0.130	−0.306***	0.223	−0.131	0.387***	−0.065	−0.028	0.146	−0.014*	−0.014
	(0.014)	(−1.540)	(−1.121)	(−3.010)	(1.599)	(−0.649)	(3.002)	(−0.636)	(−1.018)	(0.876)	(−1.961)	(−0.017)
0.80	0.027	−0.128	−0.047	−0.318***	0.219	−0.148	0.396***	−0.073	−0.014	0.137	−0.000*	−0.011
	(0.008)	(−1.380)	(−1.216)	(−3.012)	(1.178)	(−0.937)	(3.003)	(−0.543)	(−0.810)	(1.163)	(−1.957)	(−0.020)
0.90	0.023	−0.130	−0.029	−0.309***	0.227	−0.157	0.377***	−0.068	−0.015	0.129	−0.023*	−0.019
	(0.019)	(−1.487)	(−1.122)	(−2.997)	(0.667)	(−1.242)	(3.000)	(−0.830)	(−0.814)	(1.183)	(−1.948)	(−0.015)
0.95	0.028	−0.122	−0.039	−0.314***	0.210	−0.141	0.368***	−0.071	−0.021	0.131	−0.032*	−0.010
	(0.006)	(−1.601)	(−1.115)	(−3.020)	(0.882)	(−1.329)	(3.001)	(−0.950)	(−0.621)	(1.271)	(−1.938)	(−0.013)

Note: The table reports the quantile estimation results. The t-statistics are between brackets. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.
Source: Author Estimations.

Table 4
Results of quantile autoregressive distributed lag (QARDL) for ecological footprint.

Quantiles (τ)	Constant	ECM	Long-Run Estimates				Short-Run Estimates					
	$\alpha_*(\tau)$	$\rho_*(\tau)$	$\beta_{ECO}(\tau)$	$\beta_{TOR}(\tau)$	$\beta_{GDP}(\tau)$	$\beta_{GDP2}(\tau)$	$\phi_1(\tau)$	$\omega_0(\tau)$	$\omega_1(\tau)$	$\lambda_0(\tau)$	$\theta_0(\tau)$	$\acute{\epsilon}_0(\tau)$
0.05	0.005	−0.201***	−0.141***	−0.373***	0.142	−0.060**	0.467***	−0.104***	−0.032	−0.161*	0.070*	−0.021
	(0.010)	(−3.118)	(−4.121)	(−3.001)	(1.630)	(−4.008)	(3.001)	(−3.207)	(−0.010)	(−1.960)	(1.738)	(−0.128)
0.10	0.007	−0.200***	−0.134***	−0.357***	0.166	−0.070***	0.451***	−0.110***	−0.054	−0.149*	0.071*	−0.028
	(0.013)	(−3.100)	(−4.126)	(−2.992)	(1.620)	(−4.004)	(2.993)	(−3.415)	(−0.005)	(−1.957)	(1.644)	(−0.123)
0.20	0.010	−0.204***	−0.130***	−0.364***	0.174*	−0.058***	0.469**	−0.113***	−0.046	−0.151**	0.052*	−0.027
	(0.014)	(−3.316)	(−4.331)	(−3.002)	(1.642)	(4.008)	(2.979)	(−3.208)	(−0.011)	(−1.979)	(1.736)	(−0.129)
0.30	0.006	−0.208***	−0.138***	−0.346**	0.157*	−0.066***	0.458**	−0.108***	−0.052	−0.137**	0.069*	−0.027
	(0.012)	(−3.418)	(−4.237)	(−2.986)	(1.662)	(−3.016)	(2.960)	(−2.996)	(−0.006)	(−1.995)	(1.727)	(−0.121)
0.40	0.009	−0.207***	−0.150***	−0.328**	0.164*	−0.084**	0.450**	−0.114***	−0.041	−0.141**	0.057*	−0.023
	(0.009)	(−4.146)	(−3.942)	(−2.967)	(1.660)	(−2.521)	(2.939)	(−3.410)	(0.008)	(−2.036)	(1.917)	(−0.131)
0.50	0.013	−0.202***	−0.033	−0.338**	0.148*	−0.073*	0.439**	−0.120***	−0.034	−0.127**	0.066	−0.021
	(0.004)	(−4.157)	(−0.833)	(−2.947)	(1.671)	(−1.929)	(2.918)	(−3.616)	(−0.009)	(−2.085)	(0.824)	(−0.127)
0.60	0.020	−0.206***	−0.026	−0.349*	0.144*	−0.068	0.452**	−0.112***	−0.051	−0.135**	0.073	−0.017
	(0.007)	(−4.641)	(−0.927)	(−1.960)	(1.702)	(−1.518)	(2.898)	(−3.014)	(−0.005)	(−2.074)	(1.032)	(−0.117)
0.70	0.012	−0.203***	−0.011	−0.337*	0.159*	−0.056	0.437**	−0.020	−0.047	−0.117**	0.059	−0.029
	(0.003)	(−3.549)	(−1.123)	(−1.960)	(1.731)	(−1.226)	(2.871)	(−1.018)	(−0.016)	(−2.058)	(0.842)	(−0.119)
0.80	0.018	−0.202***	−0.028	−0.327	0.140*	−0.042	0.446**	−0.013	−0.038	−0.125**	0.060	−0.025
	(0.008)	(−3.342)	(−1.228)	(−1.620)	(1.750)	(−0.835)	(2.858)	(−0.821)	(−0.004)	(−2.079)	(0.952)	(−0.111)
0.90	0.015	−0.205***	−0.032	−0.342	0.161*	−0.069	0.461**	−0.001	−0.043	−0.101**	0.072	−0.026
	(0.017)	(−3.429)	(−1.334)	(−1.630)	(1.770)	(−0.927)	(2.837)	(−0.919)	(−0.013)	(−2.096)	(0.541)	(−0.115)
0.95	0.019	−0.209***	−0.022	−0.339	0.148*	−0.077	0.471**	−0.018	−0.050	−0.110**	0.057	−0.022
	(0.024)	(−3.827)	(−1.439)	(−1.610)	(1.781)	(−0.939)	(2.827)	(−0.721)	(−0.003)	(−2.086)	(0.629)	(−0.122)

Note: The table reports the quantile estimation results. The t-statistics are between brackets. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.
Source: Author Estimations.

confirmation of the revision. There is an existence of equilibrium among the variables in a longer period of time. For evaluating the EKC hypothesis, the parameter that estimates the GDP on EFP is positive, reflecting an upward and direct relationship. This means the higher level of GDP leads to a higher level of CE. On the other hand, the parameter that estimates the GDP2 on EFP was negative, reflecting a downward and inverse relationship. This means the higher level of GDP^2 leads to a lower level of EFP. Statistically, it reflects an upward direction at GDP state, and then there is the downward direction, reflecting a typical inverted U-shaped hyperbola curve. This result is the confirmation of the EKC curve, which states that when an economy of a country performs, it leads to a higher level of environmental deterioration but as soon as it becomes financially stable, it started investing in seek of productivity and efficiency, which leads to the resource optimization and eventually decrease the level of environment deterioration which as per Table 4 is measured through EFP.

On the other hand, the parameter estimating tourism on EFP and ECO on EFP, both of the integrations are found negative in which tourism was found to be negative and statistically significant among few of the quantiles, whereas ECO were also found to be negative and

statistically significant among few of the quantiles. Considering tourism, the significant and negative is a reflection that the higher level of tourism leads to lower EFP, but this is at the initial quantiles, and on the later quantiles, the relationships become insignificant. They were considering the ecological innovation that was reported significant and negative across all of the quantiles. Through ecological innovation, the level of EFP can be eliminated, which is a good direction for Turkey to pursue to eliminate the level of EFP from their operations. Similarly, the results of the short run are quite similar to the results of the long run. The overall results are summarized in Table 4.

After applying QARDL, the asymmetries were evaluated at the later stage by applying Wald's Test across all of the variables and their respective relationships. Even though this test has the limitation of not having any particular asymptotic distribution, this test can ascertain the uncertainties among all parameters, including coefficients and intercepts in both the long run and the short run. This test can also help capture the structural breaks in the data set, either they are recognized and known or not. The results are found to have symmetries as they are statistically significant for both dependent variables, CE and EFP. The overall results of the Wald test are summarized in Table 4.

5. Conclusion, discussion, and recommendations

5.1. Conclusion

In pursuing economic development, the human, social, and environmental aspects are often ignored by the companies at the micro-level and the countries at the macro level. Therefore, a regular change in climatic conditions has raised serious concern for human survival, well-being, and development, drastically affecting the other flora and fauna. To control this, there are some initiatives that the international bodies have taken to improve the environment and health globally, in which the signatory countries agreed to control the level of pollution and carbon emitted into the environment.

For a substantial financial betterment of an economy, the tourism and hospitality businesses have emerged as an industry that has shown tremendous economic positive outputs and support to an economy with the lease inputs. However, on the other side, tourism has also been reported to lead to increased environmental degradation as foreigners came to the host country and contributed to the additional economic activity. There is also an increased level of energy consumption. On the other hand, ecological innovation emerged as a potential solution for eliminating the level of carbon emissions which has recently gained intense attention whereby researchers are found to be in agreement in terms of their beneficial relationships.

Table 5
Results of the Wald test for the constancy of parameters.

Variables	Wald-statistics CO2 Emission	Wald-statistics Ecological Footprint
P	19.255*** [0.000]	26.587*** [0.000]
β_{ECO}	12.101*** [0.000]	19.087*** [0.000]
β_{TOR}	6.765*** [0.005]	9.307*** [0.000]
β_{GDP}	8.031*** [0.000]	7.689*** [0.000]
β_{GDP2}	1.260 [0.285]	1.905 [0.159]
ϕ_1	3.010** [0.029]	4.589*** [0.000]
ω_0	6.973*** [0.000]	16.088*** [0.000]
ω_1	–	0.205 [0.999]
λ_0	1.629 [0.210]	0.589 [0.758]
θ_0	3.698*** [0.000]	4.810*** [0.000]
$\acute{\epsilon}_0$	4.058*** [0.000]	10.577*** [0.000]
$\acute{\epsilon}_1$	0.891 [0.324]	–
Cumulative short-term effect:		
ω^*	–	1.058 [0.559]
$\acute{\epsilon}^*$	0.822 [0.705]	–

The p-values are between square brackets. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.
Source: Author Estimations.

6. Discussion

Turkey is a country that possesses some fine natural sites and sceneries that attract people from all over the world and is reported to be at 6th place in terms of the most visited country in 2019. However, the country is also reported to be one of the highest carbon emitters and has increased by 416% in 2014 while comparing the level of emissions from 1960. Therefore, based on Turkey as the contextual gap and the application of QARDL as the methodological contribution, the present study explores the relationship of tourism and ecological innovation within the framework of the Environment Kuznets Curve (EKC) environment spanning from 1995 to 2018.

The results reported an upward direction at GDP state, and then there is the downward direction GDP^2 which reflects a typical inverted U-shaped hyperbola curve. This result is the confirmation of the EKC curve, which states that when an economy of a country performs, it leads to a higher level of environmental deterioration but as soon as it becomes financially stable, it started investing in seek of productivity and efficiency, which leads to the resource optimization and eventually decrease the level of environmental deterioration. These findings are according to (Adedoyin et al., 2021) and (Al-Mulali et al., 2016). For the parameter estimating tourism and ECO on CE and EFP, both of the integrations are found negative in which tourism was found to be negative and statistically significant across the majority of the quantiles. In the context of tourism, the results are similar to the findings of (Adedoyin et al., 2021) as values are found to be insignificant for some of the quantiles, whereas (Chishti et al., 2020b) also reported increasing effect in the context of countries of sub-continent which are India, Pakistan and Bangladesh.

6.1. Recommendations

Based on the results, it has been recommended that the government promote a culture of research and development and accordingly channelize the investments into the area. Precisely, since the contribution of Turkey's tourism is significant, there is a need to control the level of pollution generated through tourism. This can be done by integrating environmentally friendly technologies into transportation, hotels, resorts, etc., that assist the overall tourism. On the other hand, the government should also safeguard the existing natural sites so that tourism does not cause adversely to flora and fauna, whereby the existing natural resources can catalyst the country's environmental temperature and human well-being. Moreover, the government needs to enforce legislation for environmental protection and ensure its compliance from all stakeholders so that every party understands its responsibility and acts accordingly. Most importantly, there is a need to create awareness among all stakeholders by which the safety of the environment is ensured.

Based on the limitations, it has been recommended that the application of QARDL should be made for other determinants of environment degradation, including energy consumption, transportation, and production, etc. In addition to this, the studied relationships should also be studied across different panel sets like Asian countries, BRICS, OECD, etc. In addition to this, there is a need to explore other causes that increase the level of pollution, for instance, the use of plastics and improper waste management, etc. the causes of environmental degradation can be done by the application of other operations management

techniques like instance taking expert opinion through multi-criteria decision-making technique like AHP, whereby the exploration can also be done by artificial intelligence-based machine learning technique.

Credit author statement

Yunpeng Sun: Conceptualization, Methodology, Data curation, Supervision, Writing- Reviewing and Editing, Ozlem Ates Duru: Conceptualization, Writing- Reviewing and Editing, Asif Razzaq: Methodology, Formal analysis, Software, Investigation, Supervision, Writing-Reviewing and Editing, Marius Sorin Dinca: Conceptualization, Validation, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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