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Asymmetric impacts of technology innovation and environmental quality on tourism development in emerging economies

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ABSTRACT

Tourism development contributes to higher economic output and is highly integrated with environmental quality and associated technologies. Although many studies explore the impact of tourism on carbon emissions; however, little is known regarding the effects of environmental pollution and technology innovation on tourism growth. Therefore, this study examines the impact of technology innovation and environmental pollution on inbound tourism in emerging economies. In doing so, we employ a recently developed panel quantiles regression and found that technology innovation and economic growth stimulate inbound tourism while increasing emissions limit tourist arrivals. These effects are not equally observed across all quantiles. Particularly, the impact of technology innovation is highest at higher quantiles, while the impact of the emissions is highest at lower quantiles. These results suggest that inbound tourism is asymmetrically affected by technology innovation and environmental quality of host destinations. Hence, emerging economies should encourage sustainable tourism by integrating green technologies and minimizing ecological hazards.

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1. Introduction

The tourism industry is a lucrative business opportunity for emerging economies that generate employment and significantly contributes to economic output (Ozturk et al., 2021; Sun et al., 2021). Therefore, global economies are devising policies to improve their tourism sector. While comparing with the data of the last 20 years, this industry is reported to have an annual increase of 4%, and the global number of tourists is anticipated to exceed the figures of 1.80 billion (UNWTO, 2014). However, the potential of this area can be gauged with the fact that this anticipation was proved to

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be wrong as the tourists already crossed the annual increase by 5% by contributing to the revenues by 1.4 billion, which gets possible because of the many factors including development in the tourist's destinations; improving the quality of communication and technology globalization; refining the policies and rules regarding ease of doing business, and relaxing in the visa processes are few to be mentioned (Razzaq et al., 2021). These factors lead to a tremendous improvement in this sector which makes this a quicker industry while compared with exports of goods and services, whereas tourism also leads to contribute the other economic indicators by decreasing the level of unemployment; generation of economic activities; substitute of international remittances and complementing the areas of innovation and entrepreneurship (Eyuboglu & Uzar, 2020).

Moreover, it should also be noted that tourism, its development and economic contribution are not consistent for all economies and regions despite its significant contribution to the GDP (Churchill et al., 2020). Therefore, researchers are exploring the possible determining and hindering factors that can boost or the reason for the failure of the tourism sector. Among them, researchers have reported factors including quality of logistics infrastructure (see, e.g., Khadaroo & Seetanah, 2008; Prideaux, 2000); turbulences due to terrorism (see, e.g., Arana & León, 2008; Pizam & Smith, 2000); climatic conditions and conservation policies for environment protection (see, e.g., Dwyer et al., 2013; Gössling et al., 2008; Pentelow & Scott, 2010); price and income (see, e.g., Athanasopoulos & Hyndman, 2008; Garín-Muñoz, 2009).

When a tourist plans its tourist destinations, it has been reported that environment conditions of the destinations play a game-changing role in his decision making as it was ranked highly among the others (Churchill et al., 2020; Lise & Tol, 2002). Since a tourist opts for travelling with an objective to have satisfaction and inner peace hence natural sites, destination infrastructure, and most importantly environmental quality plays an essential role in selecting the destination, whereby nobody wants to travel to an environmentally polluted place and severely deteriorate the health of the tourists (Churchill et al., 2020; Moore, 2010). The decision to travel for tourists is for the sake of recreational activity. Hence, only that destination will be selected, which is no or less life and health-threatening (Razzaq et al., 2021; Sharif et al., 2020). Though the relationship between climate conditions and tourism has been explored by several researchers in which they focused on the change in the climatic and atmospheric conditions (Buzinde et al., 2010; Hoogendoorn & Fitchett, 2018; Kaján et al., 2015; Steiger et al., 2019) whereas the contribution of tourism in polluting the environment is also be studied (Fethi & Senyucel, 2021; Khan et al., 2020a; Koçak et al., 2020), however, the role of pollution in determining the tourism is least explored (Churchill et al., 2020; Zhang, 2021).

In the current digital era, where technology plays a beneficial role in every field, it also contributes significantly to tourism development (Razzaq et al., 2021a). Precisely the role of technology innovation (TIN) is highly acknowledged by the researchers in eradicating pollution, improving productivity, and enhancing the efficiency levels of business operations, which makes them in achieving sustainability (Khan et al., 2020b; Razzaq et al., 2021d). Similarly, in the context of tourism, its contribution cannot be ignored. For instance, while designing an advertisement campaign to attract tourists, the role of digital media in tourism cannot be ruled out as this helps attract more tourists (Adeola & Evans, 2019). In addition, because of the technology integration, tourists can easily plan their trips and book their hotels and resorts while at the place of origin. In contrast, it also assists in payments and procurements (Law et al., 2018). Thus, it provides modern-day solutions to the tourism industry (Petrović et al., 2017; Razzaq et al., 2021b).

Since the responsibility of maintaining environmental quality lies on all stakeholders, including individuals, organizations and government institutions, therefore based on the discussion above, the present study intends to explore the role of environment pollution and technology innovation in complementing the tourism industry. Moreover, these relationships are explored in the emerging seven countries, including 'China, Turkey, Russia, India, Indonesia, Brazil, and Mexico'. These countries are selected based on their substantial share in global economic output and population (Gyamfi et al., 2020). Manifestly, these countries possess beautiful natural sites and destinations by which they are trying their best to reap and heap the economic benefits through tourism and its respective development. Lastly, the proposed relationship is explored using a recent technique, namely 'Methods of the Moment of Quantile Regression' (MMQR), which offers superior estimates by considering non-linearity. Unlike existing literature, this study provides asymmetric effects. It is argued that the impact of technology and the environment on tourism growth is significantly varied at lower, medium, and higher quantiles (levels) of tourism.

The rest of the research is arranged as the following section summarises the related literature review followed by research methodology, estimations, and outcome. In last, the study is concluded, and recommendations are proposed.

2. Literature review

Various researchers have explored the relationship between environmental pollution and tourism based on two viewpoints. The first category represents the group of researchers that have reported an increase in environmental pollution due to the activities made by the tourists as they increase an additional level of energy, transportation, fuels, and so on (Khan et al., 2020a; Tang et al., 2018; Zhang et al., 2021). The second belongs to the literature that emphasizes the elimination of pollution through the implementation of green operations to pursue sustainable tourism (Dogan & Aslan, 2017; Godil et al., 2021; Imran et al., 2014; Jebli & Hadhri, 2018). Nevertheless, most of the literature explores the direct relationship between tourism and pollution, whereas the cause of pollution for the increment in tourism is the least investigated (Zhang et al., 2021). Among the least, the recent study conducted by Churchill et al. (2020) in the context of G20 countries explore the role of environmental pollution in improving tourism and confirms the presence of a significant relationship, and highlights that if the destination is polluted, then there will be a smaller number of arrival of tourists. Hence these relationships require further exploration, which the present study intends to make. Xuefeng et al. (2021) argued that tourism is associated with higher emissions, and a feedback effect exists, implying that higher emissions reduce the number of tourist arrivals in the USA. Another study conducted by Zhuang et al. (2021) confirmed the emissions increasing effects of tourism in Belt and Road countries. They argued that policy coordination helps to improve tourism in partnering countries (An et al., 2021).

On the other hand, technology is transforming each industry, and it has possessed a significant impact on economic output and environmental sustainability. Razzaq et al. (2021a) argued that tourism contributes to higher economic output and higher emissions; however, green technology innovation can help to mitigate the negative consequences of tourism development. In contrast, Sun et al. (2021) found emissions mitigating effects of tourism in Turkey. They also argued that eco-innovation and tourism are imperative to reduce environmental pollution in the long run. Though researchers have not directly explored the relationship between the two, most of them considered tourism as the independent variable to draw the impact on growth or environmental quality (Paramati et al., 2018; Razzaq et al., 2021). Currently, it is impossible to perform any task without technology; therefore, eco-technologies can play a significant role in tourism development. The examples where ignorance of technology is inevitable include the development of advertising campaigns which cannot be possible without engaging the technologies; developing real-time content for attracting the tourists; providing assistance in terms of travelling, booking and lodging; improving the reception services and transmitting the real-time information regarding peak hours, traffic congestions, weather forecasts are few of the examples where technology innovation can significantly contribute and accordingly can magnify the level of tourism by attracting more tourists (Adeola & Evans, 2019; Law et al., 2018; Petrović et al., 2017; Razzaq et al., 2021c; Shin et al., 2019). Hence, the said relationship is also intended to be explored in the present study.

In addition to the phenomena above, the literature related to tourism also studies the role of economic growth (Balli et al., 2019; Shi et al., 2020; Zhang & Gao, 2016); Khan et al., 2020a) and exchange rate (Akadiri & Akadiri, 2021; Belloumi, 2010; Churchill et al., 2020; Lim, 1997), therefore in the present study, both have been incorporated as control variables.

3. Methodology

The current study employs different tests, including 'Fully Modified Ordinary Least Squares' (FMOLS), and 'Dynamic Ordinary Least Squares' (DOLS) for investigating the relationships among the variables. Normally, in the studies involving methodology of panel data sets, there are certain variances that need to be addressed. If they are not, the outcome generated without addressing such concerns could be dubious and inferior. Precisely such issues contain addressing of the 'Cross Section dependency' which itself is because of the shared variance among the cross sections within the panel dataset due to shared behaviour of the indicators in a certain situation, and heterogeneity which accordingly needed to be addressed. Hence, based on these reasons, the test by Pedroni (2004) is capable of evaluating the dynamic co-integration among the panel. Therefore, following the issues mentioned above regarding methodology of panel datasets, FMOLS is applied which is also proposed by Pedroni and has the capability to ascertain and mitigate the data distortions due to these issues, and by enabling the features of the particular intercepts, which helps it with the generation of least biased results. On the other hand, Kao and Chiang (2001) propose DOLS, which is based on Monte Carlo's framework and is efficient compared with the other OLS techniques, specifically in the smaller datasets. Moreover, endogeneity is also efficiently handled with the help of lagged and leads and their respective adjustments.

On the other hand, for apprehending the effects and presence of heterogeneity and distributional effects, and the respective in-capabilities of tests conventionally used to explore the relationships between the two or more phenomena, the need of a technique which is capable of exploring the relationships at the level of quantiles was felt by the researchers (Sarkodie & Strezov, 2019). Historically, quantile regression was applied in panel estimations and in 1978 was first proposed by Koenker and Bassett. Conventionally, the purpose of applying quantile regression is to estimate differences and variation within the dependent's variables quantiles with the independent variables' coefficients estimated through OLS-based estimations. In addition to this, the quantile regression is least prone to the presence of the outliers and its effects on the outcome; hence it shows the resilience and robustness of this technique, whereas this technique also efficiently handles the situation in which the relationship between I.V.s and D.V.s which are normally estimated based on the averages, becomes statistically insignificant thus by providing more insightful outcome it provides more precise estimations and results, which shows its legitimacy and practicality (Binder & Coad, 2011).

Moreover, the present study also employs a technique which is recent and is an estimation technique which was proposed and is related to the family of techniques estimating quantile regression by Machado and Silva (2019) that estimates based on fixed effects, namely 'Method of Moments Quantile Regression' (MMQR). Conventionally, the typical quantile-based regression estimations techniques can handle the outliers (as mentioned earlier); however, they cannot apprehend the cross sections' heterogeneity in the research design of panel data. This technique is superior from the other by estimating the effects based on covariance of the dependent variable (which in present study is T.A.), while also apprehending cross sections' heterogeneity that conventional techniques fail to account for and majorly estimates by the values of the averages merely (Koenker, 2004 and Canay, 2011). Most importantly, in the situations in which the independent variables have the attributes of endogeneity and the relationships had a particular effect that is so strong and temper the overall behaviour of the variables and their respective relationships. The legitimacy and appropriateness of these techniques is acknowledged by the researchers (Aziz et al., 2021; Razzaq et al., 2021a; 2021b). Thus, this technique is more robust and efficient while estimating the quantiles and provide insightful results even when the conditions overlap during estimations. The mathematical depiction of conditional quantiles $Q_y(\tau/X)$ of the variant presented in Equation 1.

$$Y_{it} = \alpha_i + X'_{it}\beta + (\delta_i + Z'_{it}\gamma)U_{it} \tag{1}$$

In Equation (1), the estimations of probability and the respective parameters $P\{\delta_1 + Z'_{it}\gamma > 0\} = 1.(\alpha, \beta', \delta, \gamma'\ )'$ is highly recommended. The specific effect of the variable which is fixed and is presented by i which is $(\alpha_i, \delta_i),\ i = 1, \ldots, n.$

The subsection of X and its k-vectors respectively is estimated based on Z, which are known and are computed based on the transformations having modules l that are differentiable and are presented below:

$$Z_l = Z_l(X), \ l = 1, \ldots, k \tag{2}$$

Moreover, the X_{it} and its respective distribution is similar and autonomous while relating with any particular (i) in a given period of time (t). Moreover, U_{it} and its respective distribution is similar while relating with any particular (i) in a given time (t) and is capable of generalizing after meeting the requirements that are momentary and less responsive to the pattern and respective behaviour during estimations among the independent variables, and are reported to be orthogonal to X_{it}. Thus Equation 1 is accordingly revised and presented as Equation 3.

$$Q_y(\tau/X_{it}) = (\alpha_i + \delta_i(\tau)) + X'_{it}\beta + Z'_{it}\gamma q(\tau) \tag{3}$$

In Equation 3, the independent variables' vectors are shown by X'_{it}. In addition to this, to make all of the variables behave in a standardized manner, the natural log was taken while incorporating them in any statistical analysis. Furthermore, the quantiles and their respective distribution for the dependent variable is presented by $Q_y(\tau/X_{it})$; Y_{it} represents the natural log and is based on the state of the dependent variable and the scalar's coefficients which is a numeric depiction of any particular (i) in a given period (t) and quantile's fixed effects (τ) is represented by $X'_{it} - \alpha_i(\tau) \equiv \alpha_i + \delta_i q(\tau)$. In addition to this, the intercepts are constant, which are the traditional way of computing fixed estimations in traditional least-squares techniques. The calculated parameters and the variation respectively do not change with a change in time, can freely move along the quantiles of the dependent variables and have the presence of heterogeneity. The depiction of sample's τth quantile is made by the help of $q(\tau)$ which are accordingly calculated by optimizing the results as presented in Equation 4:

$$\min_q \Sigma_i \Sigma_t \rho_\tau \left(R_{it} - (\delta_i + Z'_{it}\gamma)q\right) \tag{4}$$

In Equation 4, the function of checking is shown by $\rho_\tau(A) = (\tau - 1)AI\{A \leq 0\} + TAI\{A > 0\}$. In addition to this, as the present study intends to explore the role of tourist's arrivals (T.A.) used as a proxy for tourism by the help of level of carbon emissions (CO_2); the number of patents registered in technology used as the proxy for technology innovation (TIN); 'Real Effective Exchange Rate' (REER) as the proxy for an index of exchange rate and economic growth (GDP); the respective data for the aforementioned variables are collected from the databases of World Bank (2021) (for the data of T.A., REER and GDP); British Petroleum (2021) (for the data of CO_2); and OECD (2021) (for the data of TIN); for the E7 countries which are 'China, Turkey, Russia, India, Indonesia, Brazil, and Mexico' whereas the data of this panel is collected from the year of 1995 to the year of 2019.

4. Estimations and results

4.1. Descriptive statistics

Before examining the intended relationships among the studied variables, it is pertinent to explore its descriptive, which includes identifying the mean and standard deviation and the minimum and maximum values. In the case of T.A., the mean was found to be 3.88 with the minimum and maximum values of 3.2040 and 4.5220, respectively, whereas it has a standard deviation of 4.522. In the case of GDP, the mean was found to be 8.24 with the minimum and maximum values of 6.3565 and 9.4916, respectively, whereas it has a standard deviation of 1.5989. In the case of TIN, the mean was found to be 2.1761 with the minimum and maximum values of 1.7172 and 2.6000, respectively, while it has a standard deviation of 0.9075. In the case of CO_2, the mean was found to be 6.2331 with the minimum and maximum values of 5.3544 and 6.5222, respectively, whereas it has a standard deviation of 1.1205. Lastly, the Jarque Bera test rejects the null hypothesis of data normality, which motivates us to apply a non-linear panel model. The values from the Descriptive Statistics are presented in Table 1.

4.2. Assessment of cross-section dependence and unit root

Once the descriptive statistics have been explored, it is pertinent to assess the 'Cross-Section Dependence' (CD) and unit root in the later stage. The reasons for determining CD (as discussed earlier) includes that since the panel research design, the countries which represent the cross-sections possess a level of similarities because of their similar economic responses and behaviour; therefore, such similarities resulted in a variance which tends to temper the overall estimations and hence needs to be addressed accordingly (Ahmad & Zhao, 2018; Aziz et al., 2021). In the present study, CD is evaluated with the help of 'Cross-sectional IPS' (CIPS). This test can also apprehend the heterogeneity within the time series that the traditional tests, including Levin, Lin and Chu, and Im, Pesaran, and Shin, fail to do so (Phillips & Hansen, 1990; Raza & Shah, 2017). The hypothesis statements of this test elaborate that when the significance value is insignificant, that is greater than 0.01, 0.05 and 0.10 and lead to acceptance of the null hypothesis confirm of the absence of CD, whereas when the significance value is significant that is less than 0.01, 0.05 and 0.10 and lead to rejection of the null hypothesis is the confirmation of the presence of CD. In addition to this, hypothesis statements of CPIS tests elaborate that when the significance value is insignificant, that is greater than 0.01, 0.05 and 0.10 and lead to acceptance of the null hypothesis is the confirmation of the presence of unit root whereas when the

Table 1. Results of descriptive statistics.

Variables	TA	GDP	TIN	CO_2	REER
Mean	3.8800	8.2405	2.1761	6.2331	4.8849
Minimum	3.2040	6.3565	1.7172	5.3544	4.0338
Maximum	4.5220	9.4916	2.6000	6.5222	5.6932
Std. Dev.	1.2594	1.5989	0.9075	1.1205	1.5856
Jarque Bera P-Value	0.0000	0.0000	0.0000	0.0000	0.0000

Source: Authors' estimation.

Table 2. Results of cross-sectional dependence and CIPS unit root test.

			CIPS test	
Variables	CD Test	*p*-value	Level	1st difference
TA	19.028	0.000	0.279	−9.057***
GDP	26.354	0.000	−1.051	−6.125***
TIN	17.691	0.000	−0.846	−7.664***
CO_2	22.350	0.000	−1.331	−5.364***
REER	21.465	0.000	−0.566	−8.182***

Note. '***, ** and * represent significant level at 1%, 5% and 10%, respectively.'
Source: Authors' estimation.

Table 3. Results of stationary analysis.

	Im, Pesaran and Shin			
	I(0)		I(0)	
Variables	C	C&T	C	C&T
TA	0.826	0.703	−8.389***	−9.060***
GDP	0.294	0.346	−6.900***	−6.149***
TIN	−0.527	−0.443	−7.001***	−7.191***
CO_2	−1.443	−1.554	−6.700***	−6.483***
REER	−1.202	−1.123	−7.463***	−8.099***

Note. '***, ** and * represent significant level at 1%, 5% and 10%, respectively.'
Source: Authors' estimation.

significance value is significant that is less than 0.01, 0.05 and 0.10 and lead to rejection of the null hypothesis is the confirmation of the absence of unit root. Based on the summarised outcome shown in Table 2, the results of CD test for all of the variables confirm the presence of CD as all of the values are statistically significant as they are found to be less than 0.01. while evaluating the results of the CIPS test, the variables were reported to have unit root at level; however, when their first difference is taken, they all become statistically significant and confirms the absence of unit root in the long run, thus confirming that all of the variables are stationary (Aziz et al., 2021).

Furthermore, the existence of the stationary was also evaluated with the help of Im et al. (2003). The hypothesis statements of this test are identical to the previously applied test. Based on the summarised outcome shown in Table 3, the variables were reported to have unit root at a level; however, they all convert stationary when their first difference is taken (Aziz et al., 2021).

4.3. Panel co-integration test

After confirming the stationarity properties of data, we apply the panel co-integration test to identify the long-run association among model variables (Pedroni, 2004; Westerlund, 2007). In Pedroni's (2004) test, the evaluation of co-integration is made in two phases. Firstly, the parameters were monitored in the short run, freezing the heterogeneity and observing their deterministic tendency. In this test, seven criteria were evaluated, accordingly computed on the residual's outcome. In addition to this, this test helps standardize and generate the outcome not just within the group or indicator and evaluate them among the indicators or groups. Precisely, to assess the

Table 4. Results of Pedroni (Engle-Granger based) panel cointegration in E7 countries.

Estimates	Stats.	Prob.
TA= *f*(GDP + TIN + CO_2 + REER)		
Panel v-statistics	15.327	0.000
Panel rho-statistics	8.115	0.000
Panel PP-statistics	−6.209	0.000
Panel ADF-statistics	−7.234	0.000
Alternative hypothesis: individual A.R. coefficient		
Group rho-statistic	1.456	0.765
Group PP-statistic	−23.792	0.000
Group ADF-statistic	−29.481	0.000

Note. 'The null hypothesis of Pedroni's panel co-integration procedure is no co-integration.'
Source: Authors' estimation.

Table 5. Results of Westerlund (2007) bootstrap panel co-integration.

Statistics	Value	*Z* value	*p*-value	Robust *p*-value
Gt	−12.581	−11.446	0.000	0.000
Ga	−49.580	−38.290	0.000	0.000
Pt	−40.751	−35.522	0.000	0.000
Pa	−47.475	−48.967	0.000	0.000

Note. 'The null hypothesis of Westerlund (2007) panel co-integration procedure is no co-integration. The number of replications is 1000.The *p*-values are for a one sided test based on normal distribution. The robust *p*-value are for a one sided test based on 1000 bootstrap replications.'
Source: Authors' estimation.

co-integration within the indicators, four criteria were evaluated, namely 'panel v', 'panel rho', 'panel P.P.', and 'panel ADF' respectively. On the other hand, to evaluate the co-integration among the indicators, three criteria were evaluated, namely 'group rho', 'group P.P.', and 'group ADF'. Based on the summarised outcome shown in Table 4, all of the four criteria employed to evaluate the co-integration within the indicators are found to be statistically significant at level of 1%. These results endorse a long-run cointegrating relationship between the proposed model variables.

On the other hand, the assessment of co-integration is also made through Westerlund (2007), which has established its superiority in terms of robustness and appropriateness while comparing with the other conventional techniques (Aziz et al., 2021). In this test, four further criteria assist in examining co-integration and minimizing the possible distortions. Furthermore, this test is grounded on the statistical foundations of bootstrapping in which the outcome of the particular test is generated after multiplying the operations of results generations multiple times and then computing the significance value accordingly. Based on the summarised outcome shown in Table 5, all of the four criteria employed to evaluate the co-integration are found to be statistically significant after replicating the sample by 1000 times, thus confirming the findings of the earlier tests and further providing confirmation of the presence of the co-integration in the long run (Aziz et al., 2021).

4.4. Results of the panel estimations

After the prior assessment related to the quality characteristics of the data, the panel estimations (as already mentioned) were applied, which are 'Fully Modified Ordinary Least Squares' (FMOLS), and 'Dynamic Ordinary Least Squares' (DOLS). Firstly while

Table 6. Results of panel estimation for E7 countries.

	FMOLS			DOLS		
Variables	Coeff.	t-stats	Prob.	Coeff.	t-stats	Prob.
GDP	0.315	4.394	0.000	0.287	4.749	0.000
TIN	0.130	3.622	0.000	0.094	3.504	0.000
CO_2	−0.225	−5.201	0.000	−0.180	−3.955	0.000
REER	0.145	4.863	0.000	0.183	5.522	0.000

Source: Author Estimation.

discussing the outcome generated through FMOLS, the relationship of GDP was generated to have a positive relationship which is also statistically significant ($B = 0.315$, $p < 0.01$). It implies that there will be an increase in the TA by 0.315% when the GDP is increased by 1%. Similarly, the coefficient of TIN is positive and significant ($B = 0.130$, $p < 0.01$), indicating that a one % increase in technology instigates tourism by 0.130% in the long run. In contrast, CO_2 shows a negative relationship ($B = -0.225$, $p < 0.01$), implying that a 1% increase in emissions reduces tourism arrivals in host destinations by 0.225%. Lastly, in the case of REER, the relationship of REER was generated to have a positive and significant relationship ($B = 0.145$, $p < 0.01$), which exhibit that a 1% change in effective exchange rate increases tourism by 0.145%. Similar results are endorsed using DOLS, suggesting that technology innovation, economic growth, and exchange rate are positively associated with tourism growth, while carbon emission produces adverse effects.

Based on the results presented in Table 6, the generated results reflect the potential determinants by which the T.A. can further be improved, whereas the drawbacks can hinder tourist arrivals. Precisely, it has been observed that with an increase in GDP, there will be extra channelization of resources towards tourism, which eventually led to the development of the tourism sector. Hence, when the tourist's destinations are improved, there will be higher tourist inflows (Razzaq et al., 2021). In addition to this, the role of TIN is also reported to be determined as it will improve the level of tourism hence attracting more tourists arrivals. These findings are endorsed by existing studies (Batool et al., 2019; Haseeb et al., 2019; Khan, 2019).

Moreover, REER makes the currency level affordable for the tourists and leads the tourists with more expansion, thus improving tourism. This is in agreement with the findings of Akadiri and Akadiri (2021), Belloumi (2010), Chadeeand and Mieczkowski (1987). Most importantly, the role of CO_2 was found to be the hindering factor, and hence it is reported that for the improvement in the level of tourism, there is a need to control the level of CO_2. Although this relationship is not explored to the greater extent as discussed earlier (Zhang et al., 2021), however among such limited exploration, this is in agreement with the findings of Churchill et al. (2020).

4.5. Results of method of moments of quantile regression

The previous results are based on linear heterogeneous estimators. However, the present study explores the asymmetric relationships among the variables with the help of 'Method of Moments of Quantile Regression' (MMQR). The MMQR results are presented in Table 7, indicating substantial heterogeneity in coefficient size across lower

Table 7. Results of panel quantile estimations (MMQR).

	Quantiles								
Variables	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90
GDP	0.290*	0.293*	0.316*	0.334**	0.337**	0.351**	0.358**	0.362**	0.360**
TIN	0.059	0.092	0.104	0.109	0.115	0.127***	0.130***	0.145***	0.159***
CO_2	−0.348**	−0.307**	−0.283*	−0.254*	−0.213*	−0.175	−0.150	−0.159	−0.162
REER	0.116	0.124	0.137	0.149	0.162	0.184***	0.198***	0.208***	0.261***

Note. 'The statistics value of location and scale arrived from MMQR can be available upon request. ***, ** and * represent significant level at 1%, 5% and 10%, respectively.'
Source: Author Estimation.

Table 8. Results of heterogeneous panel causality test.

Null hypothesis	Stats	Prob.
GDP does not homogenously cause TA	24.845	0.000
TA does not homogenously cause GDP	19.020	0.000
TIN does not homogenously cause TA	34.641	0.000
TA does not homogenously cause TIN	11.698	0.000
CO2 does not homogenously cause TA	9.479	0.000
TA does not homogenously cause CO2	1.884	0.489
REER does not homogenously cause TA	31.051	0.000
TA does not homogenously cause REER	26.482	0.000

Source: Author Estimation.

and higher quantiles of respective variables. The coefficient values of GDP are significantly positive across all quantiles. However, their positive effect turns stronger when moving from lower to higher quantiles. Similarly, the coefficients of TIN are insignificant at lower quantiles; however, they turn significant at higher quantiles of T.A. The marginal impact of technology is also increasing with the increase in quantiles from lower to higher range. These results imply that technology innovation has substantial effects if countries are embodied with higher tourist arrivals.

Regarding CO_2, it revealed an interesting result as CO_2 will be significant when there is a low level of tourism as a tourist will be choosy will selecting the destination and when the tourism in a market is quite low then in such low level the impact of CO_2 will further threaten the arrivals of tourists. Moreover, it can be seen that as the level of quantiles of T.A. enhances, the role of CO_2 becomes insignificant, which reflects that when the destination market of tourism is large, the role of CO_2 becomes negligible. Lastly, for REER, the relationships were insignificant at lower T.A. quantiles but became significant at higher quantiles. This also reflects the volume of T.A. as the more affordability of the tourists will become more attractive destinations for T.A.

4.6. Assessment of heterogeneous panel causality

The results of Dumitrescu and Hurlin (2012) causality test is presented in Table 8. Test statistics and respective p-values indicate a bi-directional relationship between economic growth and tourist arrivals, technology innovation and tourist arrivals, and exchange rate and tourist arrivals. In contrast, uni-directional causality is reported from carbon emission to tourist arrivals. These results implied feedback effects in most variables, so policymakers should consider these effects while formulating policies.

5. Conclusion and recommendations

The tourism industry is considered a business that is not just profitable and lucrative but is also a progressing field that is found to be boosting the economies of the countries globally. However, it should also be noted that tourism, development, and economic contribution are not consistent for all economies and regions. Despite its contribution to the economic output, it can also fail miserably. Therefore, researchers are exploring the possible determining and hindering factors that can boost or the reason for the failure of the tourism sector. It should be noted that when a tourist plans its tourist destinations, it has been reported that the environmental conditions of the destinations play a game-changing role in his decision making as it was ranked highly among the others. Moreover, technology innovation provides modern-day solutions to the tourism industry in the current digital era.

Against the above backdrop, the present study intends to explore the role of environmental pollution and technology innovation in complementing the tourism industry from 1995 to 2019. Moreover, these relationships are explored in E7 countries by employing a recent technique, namely 'Methods of the Moment of Quantile Regression' (MMQR). The results revealed that technology innovation and economic growth stimulate inbound tourism while increasing emissions in sample countries restrict tourist arrivals. These effects are not equally observed across all quantiles. The impact of technology innovation is mainly highest at higher quantiles, while the impact of the emissions is highest at lower quantiles. These results suggest that inbound tourism is asymmetrically affected by technology innovation and environmental quality of host destinations. Hence, emerging economies should encourage sustainable tourism by integrating green technologies and minimizing ecological hazards.

These findings imply that technological innovation and pollution control should be considered imperative policy tools while devising policies to improve sustainable tourism. Embodied technologies can be deployed by improving the quality of technological infrastructure that assists tourists in selecting the destination and helps local entrepreneurs improve their sustainable operations. Moreover, environment preservation and conservation are crucial; hence there should be proper guidelines in the tourists' destinations that can govern the tourists in dealing with the ecology and environment. Moreover, sustainable transport technologies help reduce transport-related emissions from tourist travels and accommodations.

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