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THE DYNAMIC IMPACTS OF RENEWABLE ENERGY AND TOURISM INVESTMENTS ON INTERNATIONAL TOURISM: EVIDENCE FROM THE G20 COUNTRIES

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Abstract. This paper investigates the effects of the renewable energy consumption and the tourism investments along with the per capita gross domestic product (GDP), the real effective exchange rate, and trade openness on both tourism revenues (total tourism contribution to GDP) and international tourist arrivals in the sample of the G20 members. The annual data from 1995 to 2015 and the panel econometric techniques are utilized to achieve the objectives of the current paper. The results for the long-run elasticities from the panel fully modified ordinary least squares (FMOLS) estimations suggest that the renewable energy uses and tourism investments have a considerable positive impact on both the tourism revenues and the tourist arrivals. Given these results, it is argued that promoting both renewable energy and tourism investments should be considered as the major driving forces of tourism development in the G20 countries. Given these arguments, policymakers should initiate more of sustainable tourism development policies, which may assist those countries to expand the tourism industry further.

Keywords: tourism development, international tourist arrivals, tourism investments, renewable energy, panel data estimation techniques.

JEL Classification: Z32, Q42, C32.

Introduction

The tourism industry has significantly grown in both emerging and advanced economies during the last few decades. Thanks to the decline of the communication and the transportation costs, international tourist arrivals, across the globe, have increased from 278 million in 1980 to 1.2 billion in 2015 (the World Tourism Organization [UNWTO], 2017). In addi-

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tion, international tourism generated $1.26 trillion in earnings and 10% of the world's gross domestic product (GDP) in 2015 (UNWTO, 2017). Further, it is well argued in the literature that the tourism industry has a direct and positive impact on economic growth by enhancing the production level. Overall, the development of the tourism industry is considered an engine of economic growth in both emerging and advanced economies. This approach is known as the "tourism-led growth" hypothesis and several papers have emphasized that tourism is a key sector of the economy and their findings have illustrated the positive effects of tourism on economic growth (see e.g., Dwyer, Forsyth, & Spurr, 2004; Lim, 1997; Oh, 2005; Song, Dwyer, Li, & Cao, 2012).

However, the above-mentioned significant development of the tourism industry is related to a hike in energy demand, which can cause growth in the level of CO_2 emissions (Gössling & Peeters, 2015). Energy consumption in tourism consists of three main components: transportation, accommodation, and other activities. Indeed, tourism activities require a significant amount of energy consumption, which is mostly based on fossil fuels. Given that fossil fuels are the main source of CO_2 emissions, the first theoretical underpinning is that tourism activities can lead to a higher level of energy consumption and CO_2 emissions. A number of empirical papers (e.g. Scott, Peeters, & Gössling, 2010) have confirmed this theoretical expectation. Given that environmental degradation has been considered as the main reason for climate change and global warming, a number of international institutions and organizations have been raising the issue of global warming due to the high-level consumption of fossil fuel energy and raising CO_2 emission levels across the globe (Hoogendoorn & Fitchett, 2018)[1].

The second theoretical underpinning is if the energy requirement of tourism activities comes from renewable energy consumption, then this can suppress the level of CO_2 emissions. However, there could be a reverse causal relationship; i.e. CO_2 emissions and energy consumption can drive tourism indicators. For instance, a higher level of fossil fuel consumption and a higher level of CO_2 emissions may adversely affect the growth of the tourism industry. Therefore, it is very important to understand the dynamic role of whether renewable energy consumption plays a role in tourism development. In addition to that, the previous studies have failed to address the nexus between renewable energy uses and tourism development. At this stage, the effects of renewable energy on tourism development are three folds: the "direct effect", the "sustainability effect", and the "savings effect" (Irsag, Puksec, & Duic, 2012; Otgaar, 2012; Shi et al., 2013).

The first effect can be defined as the "direct effect" i.e. renewable energy can create a less-polluting environment in destination countries that can attract more tourists across the world. According to this effect, renewable energy has not only decreased the dependency on fossil fuel energy or enhancing environmental quality, but also increased the number of visitors in specific areas. At this stage, the linkage between renewable energy and tourism introduces an attractive element of tourism by implementing new technologies (power plants) (Otgaar, 2012). It is important to note that the investments in the tourism sector can

[1] A recent study, by Mardani, Streimikiene, Cavallaro, Loganathan, and Khoshnoudi (2019), provides a very comprehensive literature review on the nexus between economic growth and CO_2 emissions. The significance of this study is that it provides detailed review on 175 of research papers covering the period from 1995 to 2017. Therefore, it is a comprehensive literature review paper.

simultaneously achieve two objectives, which is, improving the tourism-related infrastructure and enhancing environmental quality by investing in renewable energy projects. Therefore, increasing investments in the tourism industry can help to build hotels, restaurants, and other infrastructure such as, energy efficiency technologies, solar energy, etc. that adds value to improve the environmental quality and all these factors positively affect the growth of the tourism industry. For this purpose, the current paper aims to analyse the effect of tourism investments on tourism development in the G20 countries using various panel data estimation techniques.

The second channel can be defined as the "sustainability effect"; i.e. renewable energy requires an application of new technologies, and this can create a long run (stable) relationship between energy demand and tourism development, which is significantly related to the sustainability of tourism development (Irsag et al., 2012).

The third channel of renewable energy on tourism development can be defined as the "savings effect" (Shi et al., 2013). Indeed, several papers have analysed the impact of the application of new technologies of renewable energy sources on energy cost savings opportunities in tourism. Furthermore, they have emphasized the positive and the direct environmental effect (energy cost saving effect) of the applications of renewable energy sources (Irsag et al., 2012; Michalena, Hills, & Amat, 2009; Shi et al., 2013; Yang, Li, Zheng, & Zhang, 2008). All of these issues make it interesting to analyse the relationship between renewable energy and tourism activities, which is the subject of the current paper.

Given that, the current paper aims to analyse the effect of renewable energy on tourism development by considering other potential determinants, such as the per capita GDP, the level of trade openness, and the real effective exchange rates. Indeed, environmental degradation can affect tourism and specifically, and can reduce the tourism activities and tourism revenue. Therefore, it is analysed whether the less-polluting countries (i.e. higher consumption of renewable energy) attract more tourists across the globe, and this is the main argument in the current paper. Given that, it is aimed to analyse to what extent a cleaner environment (the indication of renewable energy consumption) promotes tourism development (in terms of tourism revenue and tourist arrivals) in the sample of the G20 countries for the period from 1995 to 2015. In addition, it is further built the analysis based on the role of tourism investment (total investments in the travel and tourism sector) on the tourism development. Therefore, to achieve the objectives, the study employs various robust panel econometric techniques. More specifically, the paper applies the panel unit root tests to explore the order of integration of the variables and the panel cointegration test is employed to identify the long-run association among the considered models. The paper also applies the panel FMOLS method and heterogeneous panel non-causality test to examine the long-run estimates and the short-run causalities, respectively.

The novelty of this paper is that it is the first of its kind to explore the effects of renewable energy and tourism investments on tourism development in a sample of the G20 nations. Further, it also uses the most recent available data set and robust panel econometric framework for the empirical analyses. Given that, our study provides long-run estimates and short-run causalities among the selected variables. Our results established that the growth in renewable energy uses and tourism investments play an important role in promoting tourism

development in the G20 nations. Hence, we argue that higher renewable energy leads to low level of carbon emissions, while higher tourism investments assist the tourism companies to build new infrastructure facilities, which all play a substantial role in the promotion of tourism development. These findings indicate that the policy makers of the G20 nations should further strengthen the policies that assist these economies to reduce the use of fossil fuel and attract higher tourism investments. The detailed policy implications and contributions are discussed in the results section.

The remainder of the paper is organised as follows. Section 1 reviews the previous literature on the relationships between international tourism and energy variables as well as the role of energy and tourism investments as drivers of international tourism. Section 2 explains the nature of the empirical model, the data, and the econometric methodology. Section 3 provides the empirical results and implements various robustness checks for the validity of the benchmark findings. Section 4 discusses the findings in detail and potential policy implications. Finally, last section provides the conclusion.

1. Literature review

1.1. The relationship between international tourism and energy variables

The first theoretical expectation is that tourism activities lead to a higher level of energy consumption and CO_2 emissions. This hypothesis has been confirmed by the findings of the empirical papers (e.g. Gössling, 2002; Gössling et al., 2005). For example, the analysis of Gössling (2002) in 2001 demonstrates that tourism-related activities can negatively affect the environment and the role of energy use is particularly important across the globe. The findings indicate that air travel has the greatest impact on pollution. Likewise, Gössling et al. (2005) implement the empirical exercises based on the data for Australia, Canada, Finland, New Zealand, and the United States (U.S.) in 2002, and they indicate the significant carbon dioxide emissions due to the tourism-related activities.

Similarly, using the impulse-response analysis and the variance decompositions, Katircioglu (2014) demonstrates that tourism development is positively related to both the energy consumption and the level of carbon dioxide emissions in Turkey for the period from 1960 to 2010. Considering the bottom-up approach, Tang, Shang, Shi, Liu, and Bi (2014) find that the development of the tourism industry leads to a hike in the level of CO_2 emissions in China for the period from 1990 to 2012. Using the data on international tourist hotels, Tsai, Lin, Hwang, and Huang (2014) show that the development of the tourism industry is positively related to the energy consumption and the level of CO_2 emissions in Taiwan[2]. At this stage, environmental degradation is considered to be the main reason for climate change and global warming, especially during the last two decades. The second theoretical underpinning is if the energy requirement of tourism activities comes from clean energy plants (the renewable energy consumption) then it plays an important role in minimizing the adverse effect of the tourism industry on the environment by reducing fossil fuel consumption and CO_2 emis-

[2] Samut (2017) and Yazdani-Chamzini, Fouladgar, Zavadskas, and Moini (2013) highlight the significance of renewable energy and propose an alternative model for the renewable energy.

sion growth. According to Scott (2011), although the sustainability of tourism development requires a significant energy use, it does not necessarily cause a hike in CO_2 emissions (even it can suppress the level of CO_2 emissions by implementing more clean energy plants and technology). Paramati, Alam, and Chen (2017) examine the effect of tourism development on CO_2 emissions across the panels of developed and developing economies. Their findings show that the tourism growth leads to further environmental degradation across the economies. In another study, Paramati, Shahbaz, and Alam (2017) suggest that the tourism development has a varying impact on the environment. More specifically, authors indicate that the tourism has a positive impact on CO_2 emissions in Eastern European Union (EU), while it has a negative effect in Western EU countries.

Overall, this branch of the literature illustrates that there is a causal relationship that runs from tourism to CO_2 emissions and energy consumption. The effects of the tourism development on CO_2 emissions and energy consumption is statistically significant; however, their nature of the association varies among the countries.

1.2. Drivers of international tourism: the role of energy and tourism investments

There could also be a reverse causal relationship; i.e. (renewable) energy consumption can drive international tourism indicators. The current paper aims to test a hypothesis on whether renewable energy and tourism investments are the potential drivers of international tourism. The main idea of the related hypothesis comes from the "direct", the "sustainability", and the "savings" effects that have been discussed in the introduction section. At this point, a number of researchers have also investigated the effect of environment on tourism. For example, Bode, Hapke, and Zisler (2003) indicate that increasing level of greenhouse gases is reflected in climate change, and thus it negatively affects the tourism industry. According to their findings, holiday facilities should be supplied with different sources of energy (e.g. solar and wind energy), which releases almost no greenhouse gases. In short, they suggest that the level of CO_2 emissions (as the main source of greenhouse gas emissions) should be decreased for ensuring the sustainability of tourism development.

Similarly, Shi et al. (2013) indicate that not only solar and wind energy sources, but also the energy from the waste biomass (green waste) can be used for promoting tourism attractions. Their estimations for 385 tourist attractions in 16 cities of the Yangtze River Delta of China indicate that there is a positive development in the region's tourism industry as the energy from the green waste increases. In short, Liu et al. (2011) and Shi et al. (2013) document that renewable energy sources are positively related to the tourism industry development in the regions of China. A recent study by Paramati, Alam and Lau (2018) investigate the impact of tourism investments on tourism development and CO_2 emissions in a sample of 28 EU countries. Authors utilize annual data from 1990 to 2013 and employ several robust panel econometric techniques. Their results confirm that tourism investments have positive and negative effects on tourism development and CO_2 emissions in the EU nations. This implies that the growth in tourism investments work in favour of sustainable tourism development in the EU countries. Similarly, Alam and Paramati (2017) examine the effect of tourism investments on tourism development and CO_2 emissions in a sample of 10 major tourism based economies. Their findings establish that tourism investments not

only promote tourism development but also play an important role in reducing the level of CO_2 emissions. Likewise, Hoogendoorn and Fitchett (2018) argue that climate change has a considerable negative impact on the rapidly growing tourism industry in several African countries. Given that, the African countries are relatively poor countries and their economic growth depend on tourism receipts, the effect of climate change on the tourism industry is even more crucial in these countries.

To conclude the above literature review, there is a lack of empirical findings for the impact of renewable energy consumption on tourism development. Most of the existing literature analyse the causal relationship between the variables of tourism development, carbon dioxide emissions, and energy consumption, but ignores their dynamic linkages and a possible reverse causality. For this purpose, the current paper aims to fill this gap by analysing not only the effects of GDP per capita, the real effective exchange rates, the trade openness, but also the renewable energy consumption, and the tourism investments on tourism development in the G20 countries for the period from 1995 to 2012. The findings derived from the current paper will add significant value to the body of knowledge on the role of renewable energy uses and tourism investments in tourism development. Furthermore, the paper provides substantial policy recommendations, which would be crucial for the policy and practice.

2. Model specification, data, and methodology

2.1. Empirical models and data

This section describes the methodology that is used to investigate the dynamic association between renewable energy consumption, tourism development, and tourism investments. For this purpose, the paper aims to achieve two main objectives: First, it aims to examine the effect of renewable energy consumption on tourism development; and second, it explores the impact of the tourism investment on the tourism development in the sample of the G20 countries using annual data from 1995 to 2015. To achieve the first objective, the paper develops the following model:

$$TD_{it} = \alpha + \beta_1 REER_{i,t} + \beta_2 PI_{i,t} + \beta_3 REC_{i,t} + \beta_4 TO_{i,t} + _{i,t}, \quad (1)$$

where, *TD*, *REER*, *PI*, *REC*, and *TO* represent the total tourism contribution to GDP in billion USD, the real effective exchange rate index (2010 = 100)[3], the GDP per capita (constant 2010 USD), the renewable energy consumption (TJ), and the trade openness (% of GDP), respectively. ε_i denotes the error term in the model, and the subscripts *i* and *t* denote country and year, respectively. Eq. (1) implies the output (revenue) of tourism sector depends on the real the effective exchange rates, the GDP per capita, the renewable energy consumption, and the trade openness. Among controls, GDP per capita captures the "income effect", the real effective exchange rate captures the "price effect", and trade openness addresses the role of economic globalization in the international tourism demand (Ongan & Gozgor, 2018). Renewable energy is the main variable of interest.

[3] The real effective exchange rates data on Argentina, India, Indonesia, and Turkey was not available from the World Development Indicators (WDI); hence, these data are collected from the Federal Reserve Bank of St. Louis.

In addition, it is also aimed to explore the impact of the tourism investment on the tourism development by applying the following specification:

$$TD_{it} = \alpha + \beta_1 REER_{i,t} + \beta_2 PI_{i,t} + \beta_3 TI_{i,t} + \beta_4 TO_{i,t} + {}_{i,t}, \quad (2)$$

where *TI* is the tourism investments in billion USD. Finally, it is proceeded to provide two additional robustness checks by replacing the tourism revenue (*TD*) with international tourist arrivals in millions (*TA*):

$$TA_{it} = \alpha + \beta_1 REER_{i,t} + \beta_2 PI_{i,t} + \beta_3 REC_{i,t} + \beta_4 TO_{i,t} + {}_{i,t}; \quad (3)$$

$$TA_{it} = \alpha + \beta_1 REER_{i,t} + \beta_2 PI_{i,t} + \beta_3 TI_{i,t} + \beta_4 TO_{i,t} + {}_{i,t}. \quad (4)$$

The related data on REER, PI, TO and TA are obtained from the World Development Indicators (WDI), while data on REC is sourced from the dataset for the Sustainable Energy for All. Finally, data on TD and TI are collected from the World Travel and Tourism Council (WTTC). In addition, the definition of the variables and the data source are provided in Appendix.

2.2. Econometric methodology

The long-run relationship among variables is examined through the panel cointegration methodology. Furthermore, it is investigated the long-run effect of renewable energy consumption on tourism development by employing a non-parametric approach, i.e. the panel FMOLS estimation technique. Finally, it is implemented the panel non-causality test to establish the short-run causalities among these variables.

Firstly, the seminal paper by Nelson and Plosser (1982) about the presence of unit root in time series has led to a significant theoretical and applied research since the 1980s. Scholars have recognized the importance of unit root tests in empirical estimation. Hence, a number of panel unit root tests have been developed. Given that, it firstly analysed the unit root characteristics of the data through the use of panel unit root tests. More specifically, it is applied three panel unit root tests, such as the Levin, Lin, and Chu (LLC) (2002), Im, Pesaran, and Shin (IPS) (2003), and the Augmented Dickey-Fuller (ADF) (Maddala & Wu, 1999) for identifying the order of integration of the variables.

Secondly, the long-run equilibrium relationship between the variables of interest is examined using the panel cointegration method. The current paper applies the Fisher-type Johansen cointegration methodology. Unlike the conventional cointegration tests based on the Engle-Granger approach (Engle & Granger, 1987; Engle & Yoo, 1987), the Fisher-type test follows the Johansen's approach, which allows for more than one cointegrating relationship. Both the Trace test and the Maximum-eigenvalue (Max-Eigen) test are able to test the number of cointegrating vectors when there are more than two variables in the cointegrating system. Based on the test statistics of the Trace and the Max-Eigen, it can be determined and identified the presence of cointegrating vectors. The panel cointegration technique is more suitable for the sample because the time dimension of each country is relatively short. Therefore, the use of panel cointegration technique not only produces the asymptotically unbiased estimators but also considers the parameters that are free from nuisance. Hence, unbiased

findings can be obtained regarding the cointegrating relationships, which are asymptotically free from heterogeneity in the short term.

Thirdly, a long-run cointegrating vector was also estimated from Eq. (1) to Eq. (4), to uncover the long-run tourism development elasticities. It is applied the nonparametric approach of the panel FMOLS estimation technique to avoid the problem of nuisance parameters due to the possible existence of serial correlation and endogeneity among the variables that are considered in the model (Pedroni, 2001a, 2001b). The advantage of the panel FMOLS is that it illustrates the consistent analysis of a common value for the cointegrating vector (Pedoni, 2001b).

Finally, it is attempted to examine the dynamic bivariate causal relationships between the variables in a panel setup, while taking into account heterogeneity across countries. It is applied the heterogeneous panel non-causality test of Dumitrescu and Hurlin (2012) to examine the causal relationships in the short-run and to test the validity of the null hypothesis of homogeneous non-causality against the alternative hypothesis of heterogeneous non-causality.

3. Empirical findings and discussion

3.1. Preliminary analysis of the data

The current paper begins the preliminary analysis with the summary statistics on the selected variables of the sample countries. The summary statistics are displayed in Table 1.

Among the G20 countries, the total contribution of the tourism sector (*TD*) to the GDP is highest in the U.S., while other higher tourism revenue countries are China, Germany, and Japan, respectively. Relatively, South Africa, Indonesia, Turkey, Argentina, Korea, Saudi Arabia, and Russia have lower tourism revenues. Similarly, France receives the highest average international tourists (*TA*) per year and the second and the third position occupied by the U.S. and China. On the other hand, Argentina, Brazil, and India received less than 5 million international tourists per year. The statistics also show that both the U.S. and China have more than 40 billion USD investments per year in the tourism and travel sector (*TI*). On the other hand, a number of other countries have less than 5 billion USD investments in tourism, such as South Africa and Mexico. As expected, China, India, and the U.S. have the highest renewable energy consumption (*REC*) among the G20 countries, whereas Saudi Arabia has the least renewable energy consumption. The average trade openness (*TO*) level is significantly higher in Korea, Saudi Arabia, and Canada, while it is lowest in Brazil, the U.S., and Japan. Finally, the countries like Australia, the U.S., Canada, and Japan have more than 40K USD per capita GDP (*PI*), whereas India has less than 2K USD per annum. Overall, the G20 countries have more than 210 billion USD in revenue from the tourism sector, while they also receive more than 21 million international tourists per year on average.

In the next step, it is provided the average annual growth rates for the considered variables of the paper using the annual data from 1995 to 2015. The average growth rates are displayed in Table 2.

Table 1. Summary statistics on panel data set, 1995–2015

Country	TD	TA	TI	REC	TO	PI	REER
Argentina	54.80	3.97	5.51	201469.98	31.17	9013.66	151.46
Australia	123.33	5.31	14.46	230232.19	40.51	47780.26	85.76
Brazil	151.95	4.78	18.11	3109705.10	23.68	9907.17	80.33
Canada	76.21	17.77	8.25	1554690.86	69.27	45406.01	86.47
China	496.90	42.34	72.01	8543635.52	46.54	3243.16	96.49
France	221.41	75.80	27.40	628262.58	53.21	39313.48	99.58
Germany	365.69	22.70	23.58	614703.90	68.48	39960.62	102.35
India	127.27	4.82	17.83	6831839.00	38.63	1058.61	92.00
Indonesia	38.95	6.10	6.28	2152584.00	54.48	2720.00	86.36
Italy	219.24	40.84	13.85	448499.11	50.32	35585.70	97.60
Japan	354.68	7.16	28.47	488247.36	25.92	43634.42	99.44
Korea	61.11	7.11	7.77	54373.71	77.82	18495.80	119.85
Mexico	128.16	22.13	3.88	429483.91	56.20	8727.27	101.49
Russia	64.75	22.60	5.31	560856.26	53.98	8775.92	80.72
Saudi Arabia	62.02	9.86	28.83	243.16	75.58	19174.95	109.15
South Africa	22.97	7.25	3.67	423938.80	55.90	6596.42	91.55
Turkey	54.77	21.30	9.24	406834.80	47.50	9817.62	82.77
The United Kingdom	240.65	26.80	15.82	139302.62	53.88	37557.24	114.48
The United States	1250.58	54.42	139.57	3624470.05	25.91	46645.58	107.73
Average	216.60	21.21	23.68	1602282.78	49.95	22811.26	99.24

Note: TD – Total tourism contribution to GDP in billion US$; TA – International tourist arrival in millions; TI – Tourism investment in billion US$; REC – Renewable energy consumption (TJ); TO – Trade (% of GDP); PI – GDP per capita (constant 2010 US$); REER – Real effective exchange rate index (2010 = 100).

Table 2. Average annual growth rates, 1995–2015 (percent)

Country	TD	TA	TI	REC	TO	PI	REER
Argentina	3.12	5.05	9.49	2.35	2.34	1.77	–3.44
Australia	2.07	3.62	9.42	2.24	0.54	1.84	1.46
Brazil	2.17	7.18	5.37	2.71	2.88	1.45	–0.17
Canada	3.99	0.43	6.57	0.46	–0.16	1.49	0.42
China	10.63	5.66	11.52	0.02	1.26	8.70	2.81
France	1.06	1.76	3.86	1.41	1.85	1.01	–0.67
Germany	0.74	4.46	5.45	9.38	3.61	1.37	–1.07
India	5.54	10.86	16.44	1.53	3.49	5.35	0.85
Indonesia	3.15	4.82	7.90	1.10	0.79	2.85	0.22
Italy	1.42	2.59	1.88	7.18	1.31	0.19	0.54

End of Table 2

Country	TD	TA	TI	REC	TO	PI	REER
Japan	–0.07	10.62	0.90	2.13	4.39	0.80	–2.75
Korea	2.70	6.81	2.59	12.40	2.89	3.74	0.49
Mexico	3.49	2.54	19.83	0.20	2.37	1.41	1.40
Russia	2.74	6.82	3.88	–1.18	–0.23	3.42	2.44
Saudi Arabia	2.06	9.74	2.89	–0.36	0.83	0.78	0.35
South Africa	5.66	3.94	8.31	1.77	2.17	1.60	–1.30
Turkey	7.94	9.88	8.62	1.23	1.05	3.37	2.02
The United Kingdom	0.80	2.47	7.37	11.28	0.71	1.54	0.87
The United States	2.48	3.11	4.41	4.05	1.35	1.50	0.81
Average	3.25	5.39	7.19	3.15	1.76	2.33	0.28

Note: Average growth rates were calculated using before log conversion data. TD – Total tourism contribution to GDP in billion US$; TA – International tourist arrival in millions; TI – Tourism investment in billion US$; REC – Renewable energy consumption (TJ); TO – Trade (% of GDP); PI – GDP per capita (constant 2010 US$); REER – Real effective exchange rate index (2010 = 100).

The growth rates on tourism development indicate that Japan has only the negative growth rate, while all other countries have shown positive growth during the sample period. Among the G20 members, China, Turkey, South Africa, and India have more than five percent growth rate in tourism development, while Germany and the United Kingdom (UK) have less than one percent growth. Some countries have shown tremendous growth in the tourist arrivals, such as India and Japan, which have more than 10 percent growth; while only Canada has a less than one percent growth. It is interesting to find out that none of the G20 members have negative growth rate in tourism investments. More specifically, Mexico, India, and China have more than 10 percent growth in tourism investments, while Japan has only a less than one percent growth. Both Korea and the UK have more than 10 percent growth in renewable energy consumption, whereas the countries like Russia and Saudi Arabia have negative growth rates. All of the G20 countries have shown the positive growth in the trade openness except Russia and Canada. Finally, as it is expected, all of the G20 countries have the positive growth rates in the per capita income. Both China and India have more than 5 percent growth in per capita income, while Italy, Saudi Arabia, and Japan have less than one percent growth. In summary, these growth rates imply that the G20 countries have achieved significant growth in tourism revenue, tourist arrivals, tourism investments, and renewable energy consumption.

3.2. Findings on order of integration of the variables

To begin the empirical analysis, firstly, it is aimed to identify the order of integration of the variables. This is an important step as it helps us to select the suitable empirical models to achieve the objectives of the paper. For this reason, it is used three-panel unit root tests such as the LLC, the IPS, and the ADF. The LLC test functions by assuming common unit root

Table 3. Panel unit root tests

Variable	Method	LLC	IPS	ADF	LLC	IPS	ADF
		Level			First difference		
TD	Statistic	–0.932	–0.539	42.159	–6.350***	–4.530***	84.650***
	Prob.	0.176	0.295	0.296	0.000	0.000	0.000
TI	Statistic	3.015	–1.028	39.260	–6.119***	–8.665***	142.059***
	Prob.	0.999	0.152	0.413	0.000	0.000	0.000
REC	Statistic	2.004	0.416	44.516	–3.820***	–6.597***	115.219***
	Prob.	0.978	0.661	0.217	0.000	0.000	0.000
TO	Statistic	10.170	0.769	29.025	–6.080***	–5.479***	96.467***
	Prob.	1.000	0.779	0.852	0.000	0.000	0.000
PI	Statistic	0.722	–0.749	38.742	–7.518***	–4.739***	90.759***
	Prob.	0.765	0.227	0.436	0.000	0.000	0.000
REER	Statistic	4.701	0.444	28.658	–5.898***	–4.264***	82.901***
	Prob.	1.000	0.671	0.864	0.000	0.000	0.000

Notes: TD – Total tourism contribution to GDP in billion US$; Tourism investment in billion US$; REC – Renewable energy consumption (TJ); TO – Trade (% of GDP); PI – GDP per capita (constant 2010 US$); REER – Real effective exchange rate index (2010 = 100). Probability values for Fisher ADF test are computed using an asymptotic Chi-square distribution, while LLC and IPS tests assume asymptotic normality; the unit root tests are estimated using constant and trend variables; *** indicates rejection of the null hypothesis of a unit root at the 1% significance level.

process, while the IPS and the ADF tests work by assuming individual unit root process. All of these unit root tests, in general, have the common null and the alternative hypotheses. The results of these tests on the level and the first difference data series are displayed in Table 3.

It is estimated that the LLC, the IPS, and the ADF tests using the constant and the time-trend variables in the models. The findings from these panel unit root tests show that the null hypothesis of a unit root cannot be rejected across all the variables. These results, therefore, suggest that none of the variables are stationary at the levels. Hence, the current paper applied these unit root tests again on the first order difference of the data series. The findings from unit root tests confirm the rejection of the null hypothesis of a unit root for all of the variables at the first order differences. Given these results, it is argued that the current variables are integrated of order I(1). Most of the previous empirical studies report what if the considered variables are integrated of I(1) then there may be a long-run association between the variables. The paper explores this issue in the following section.

3.3. Findings of long-run cointegration relationship

Given the order of integration of the variables, which is confirmed from the panel unit root tests, the paper investigates the long-run association among the variables of Eq. (1) and Eq. (2). To examine the cointegration relationship between the variables, it is used of the Fisher-Johansen panel cointegration test. The results of this test are reported in Table 4.

Table 4. Panel cointegration test

Hypothesized	Fisher Statistics							
No. of CE(s)	trace test	Prob.	max-eigen test	Prob.	trace test	Prob.	max-eigen test	Prob.
	TD = f (REER, PI, REC, TO)				*TD = f (REER, PI, TI, TO)*			
None	458.300***	0.000	296.900***	0.000	732.800***	0.000	457.500***	0.000
At most 1	224.400***	0.000	158.500***	0.000	349.000***	0.000	220.700***	0.000
At most 2	99.750***	0.000	72.310***	0.001	166.300***	0.000	111.800***	0.000
At most 3	60.110**	0.013	52.550*	0.058	85.250***	0.000	66.660***	0.003
At most 4	51.770*	0.067	51.770*	0.067	50.460*	0.085	50.460*	0.085

Notes: TD – Total tourism contribution to GDP in billion US$; TI – Tourism investment in billion US$; REC – Renewable energy consumption (TJ); TO – Trade (% of GDP); PI – GDP per capita (constant 2010 US$); REER – Real effective exchange rate index (2010 = 100). Probabilities are computed using asymptotic Chi-square distribution; the estimated cointegration test models assume the linear and deterministic trend; *, **, and *** indicate rejection of the null hypothesis of no cointegration at the 10%, 5%, and 1% significance levels, respectively.

The Fisher-Johansen cointegration test results of the Trace and the Max-Eigen tests indicate that the null hypothesis of no cointegration is strongly rejected for both the models. This evidences that there is a considerable long-run equilibrium association between the variables of tourism development, the real effective exchange rates, the per capita income, renewable energy consumption, and trade openness. Similarly, the long-run association exists between the variables in tourism development, the real effective exchange rates, the per capita income, trade openness, and tourism investments. Given these results, it is argued that tourism development is significantly associated with renewable energy consumption and tourism investments in the long-run in the sample of the G20 economies. These findings further indicate that the tourism development in the G20 members is strongly associated with the growth of renewable energy uses and tourism investments in the long-run. Therefore, the policymakers should pay attention to the promotion of renewable energy sources and tourism investments in these countries to witness the further expansion of the tourism industry.

3.4. Findings of long-run elasticities for tourism

The panel cointegration test results show the significant long-run relationship among the variables of Eq. (1) and Eq. (2); however, the cointegration test results did not indicate the nature of cause and effect relationship between tourism development, renewable energy consumption, and tourism investments. Hence, the current paper applies the panel FMOLS method to investigate the role of renewable energy consumption and tourism investments on tourism development in the sample of the G20 countries. The findings of the panel FMOLS estimations are presented in Table 5.

According to the results, a 1 percent growth in renewable energy consumption and tourism investment increase tourism development by 0.162 percent and 0.135 percent, respectively. The long-run elasticities from the Eq. (1) indicate that renewable energy consumption; along with the per capita income significantly promote tourism development in the G20

Table 5. Long-run estimates using non-parametric (panel FMOLS) approach

Variable	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
	TD = f (REER, PI, REC, TO)			*TD = f (REER, PI, TI, TO)*		
REER	0.278***	194.213	0.000	–0.039***	–3.127	0.002
PI	0.439***	1921.365	0.000	0.717***	18.953	0.000
REC	0.162***	2396.161	0.000			
TI				0.135***	24.943	0.000
TO	–0.644***	–4399.151	0.000	0.094***	8.047	0.000

Notes: TD – Total tourism contribution to GDP in billion US$; TI – Tourism investment in billion US$; REC – Renewable energy consumption (TJ); TO – Trade (% of GDP); PI – GDP per capita (constant 2010 US$); REER – Real effective exchange rate index (2010 = 100). *** indicate the significance levels at 1%.

economies. Similarly, the long-run elasticities from the Eq. (2) show that the growth in tourism investments, the per capita income, and trade openness positively contributes to tourism development in the G20 countries, while the real effective exchange rates adversely affect tourism development. These results show that renewable energy consumption has a slightly higher impact on tourism development than that of tourism investments.

3.5. Robustness checks of the findings of long-run elasticities for tourism

Furthermore, the current paper undertakes the additional analysis for the purpose of robustness analysis of the benchmark findings on the tourism development. More specifically, it is investigated the long-run elasticities using the panel FMOLS models. The dependent variable (tourism revenue) is replaced with another tourism indicator, such as international tourist arrivals (*TA*). The purpose here is to see how the growth rates of renewable energy consumption and tourism investments affect international tourist arrivals in the G20 countries[4]. The results of these models are disclosed in Table 6.

Table 6. Robustness check: Long-run estimates using non-parametric (panel FMOLS) approach

Variable	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
	TA = f (REER, PI, REC, TO)			*TA = f (REER, PI, TI, TO)*		
REER	–0.213***	–6.262	0.000	–0.214***	–6.448	0.000
PI	0.964***	102.498	0.000	0.989***	146.415	0.000
REC	0.147***	11.462	0.000			
TI				0.043*	1.863	0.063
TO	0.529***	37.025	0.000	0.636***	38.925	0.000

Notes: TA – International tourist arrival in millions; TI – Tourism investment in billion US$; REC – Renewable energy consumption (TJ); TO – Trade (% of GDP); PI – GDP per capita (constant 2010 US$); REER – Real effective exchange rate index (2010 = 100). * and *** indicate the significance levels at the 10% and 1%, respectively.

[4] The results of the panel unit root tests and the panel cointegration analysis confirm the existence of the long-run relationship between the tourism arrivals and the control variables. The results are not reported to save space.

According to the results, a 1 percent growth in renewable energy consumption and tourism investment increase international tourist arrivals by 0.147 percent and 0.043 percent, respectively. The robustness check results also suggest that renewable energy consumption and tourism investments have a considerable positive effect on international tourist arrivals. As expected, the growth rates in the per capita income and trade openness also positively support international tourist arrivals. These findings again confirm that renewable energy consumption has a slightly higher impact on tourism development than that of tourism investments. In contrast, the growth in the real effective exchange rates negatively affects international tourist arrivals.

3.6. Findings on short-run causal relationships

Finally, the current paper investigates the short-run causalities between the variables of tourism development, tourism investments, renewable energy consumption, trade openness, per capita income, and the real effective exchange rates. For this purpose, the paper utilizes the heterogeneous causality framework of Dumitrescu and Hurlin (2012) to estimate the short-run dynamics among the variables. The short-run causalities are displayed in Table 7. The findings show one-way causality that runs from the per capita income to tourism development. A bi-directional causal relationship is also found that runs from tourism investment to tourism development as well as from tourism development to tourism investment. Overall, the short-run findings on the causality analysis imply that the per capita income causes tourism development, and there is a significant feedback association between tourism development and tourism investments.

Table 7. Short-run heterogeneous panel non-causalities

Null Hypothesis:	Zbar-Stat.	Prob.
Tourism development (TD) causalities		
REER does not homogeneously cause TD	–1.312	0.190
TD does not homogeneously cause REER	1.154	0.249
PI does not homogeneously cause TD	2.601***	0.009
TD does not homogeneously cause PI	–0.635	0.526
REC does not homogeneously cause TD	–0.022	0.983
TD does not homogeneously cause REC	–1.151	0.250
TO does not homogeneously cause TD	1.385	0.166
TD does not homogeneously cause TO	–0.553	0.580
TI does not homogeneously cause TD	2.673***	0.008
TD does not homogeneously cause TI	2.395**	0.017

Notes: TD – Total tourism contribution to GDP in billion US$; TI – Tourism investment in billion US$; REC – Renewable energy consumption (TJ); TO – Trade (% of GDP); PI – GDP per capita (constant 2010 US$); REER – Real effective exchange rate index (2010 = 100). ** and *** indicate the significance levels at 5% and 1%, respectively.

4. Discussion of the findings and policy implications

Given the findings of the long-run estimations, it is drawn a number of policy implications, which are useful for the implementation of sustainable tourism development policies with respect to the G20 members. More specifically, the findings established that the growth in renewable energy consumption positively contributes to tourism development in terms of tourism revenues and international tourist arrivals. These results advise that the low level of CO_2 emissions due to the higher level of renewable energy consumption attracts more international tourists. Hence, renewable energy consumption not only attracts a large number of international tourists but also helps the tourism industry to generate more income from these tourists (Otgaar, 2012). Consequently, the value added by the tourism sector to the GDP significantly increases over time. Therefore, the policymakers of the G20 economies should realize that the higher level of renewable energy consumption has several positive implications for the economy and society. For instance, increasing renewable energy consumption helps to avoid the use of fossil fuel energy, which is more carbon intensive. Consequently, promoting renewable energy helps to reduce the level of carbon dioxide emission in the country (Shi et al., 2013). A lower level of environmental pollution may attract more international tourists and may provide employment and income opportunities for the local communities. Hence, renewable energy provides an opportunity for the tourism industry to grow further and potentially assist those economies to address some of the basic socioeconomic issues, such as unemployment and income inequality. Given these arguments, policymakers should initiate more of sustainable tourism development policies, which may assist those countries to expand the tourism industry further.

Furthermore, the results indicate that the growth in tourism investments also positively contributes to tourism revenues and international tourist arrivals in the G20 countries. These results imply that tourism investments play an important role in promoting the tourism industry. The tourism investments may help to the tourism industry to build new hotels and restaurants, use of more energy efficient and renewable energy sources, adopt more environment-friendly transportation activities, and may also be using print and electronic media to advertise the tourism-related activities that they might be carrying out. Therefore, sustainable tourism investments might have played a significant role in minimizing the adverse effect of the tourism industry on the environment and might have developed attractive infrastructure developments in the tourism sector. These all factors may be positively contributed to the tourism industry to develop further in terms of revenue and attract more international tourists (Irsag et al., 2012). Given the positive effect of tourism investments on tourism revenue and international tourist arrivals, policymakers need to further introduce tourism investment policies, which should attract more investments in the tourism industry.

Conclusions

The G20 countries are considered as the major players in global tourism development. For instance, according to the data of the UNWTO (2017), the G20 economies accounted 47 percent, 74 percent, and 66 percent of global international tourist arrivals, tourism investments, and tourism revenues in 2012, respectively. These statistics indicate that the G20

countries play a significant role in the global tourism economy and that's why the current paper focuses on the G20 countries. The previous studies in the tourism literature have mainly focused on the effect of tourism on economic development and the environment. However, it is not very clear to what extent renewable energy consumption and tourism investments promote tourism development. For this purpose, the current paper aimed to investigate the effects of renewable energy consumption and tourism investments on tourism revenues and international tourist arrivals in the G20 countries. Using the annual data from 1995 to 2015, the current paper employed the panel unit root tests, the panel cointegration analysis, the panel FMOLS estimations, and the heterogeneous non-causality test procedure to examine the order of integration of the variables, the long-run relationship, the long-run elasticities, and the short-run causality relationships, respectively.

The empirical results showed that renewable energy consumption played an important role in enhancing tourism revenue and attracting international tourist arrivals. The results also indicated that tourism investments played a considerable role in tourism development. These results implied that both renewable energy consumption and tourism investments are important drivers of tourism development in the G20 countries. Given these results, it is argued that international tourists might have given more preferences to visit the countries that have less environmental pollutions. Therefore, renewable energy consumption might be a driving force of tourism development. In addition, it is argued that tourism investments also played an important role to promote the tourism industry. For example, tourism investments help to build attractive infrastructures, such as hotels, restaurants, and travel vehicles, as well as other eco-friendly infrastructures, such as energy efficiency, emission control technologies, and access to renewable energy sources. In such a way, tourism investments not only attract international tourists but also work effectively to reduce the adverse effect of the tourism industry on the environment.

Given these arguments, it is suggested the policymakers of the G20 economies to initiate sustainable tourism policies in the form of tourism investments, use of more renewable energy sources, and adopting eco-friendly tourism activities. These all factors will further assist those economies to move towards sustainable tourism development. However, the results are obtained from the G20 countries, and this is the limitation of the current study. Furthermore, the potential drivers of sustainable tourism development can be different for each country and this limits the implications. Therefore, future studies on the related subject can focus on other developing economies and developed countries by using panel data or a time-series analysis.

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APPENDIX

Definition of the variables and the data sources

Variable	Measure	Label	Data Source
Total Tourism Contribution to GDP	In Billion US$	TD	World Travel and Tourism Council
International Tourists Arrival	In Million	TA	World Development Indicators
Tourism Investment	In Billion US$	TI	World Travel and Tourism Council
Renewable Energy Consumption	TJ	REC	Sustainable Energy for All
Trade	% of GDP	TO	World Development Indicators
GDP per Capita	Constant Price in 2010 US$	PI	World Development Indicators
Real Effective Exchange Rate	Index, 2010 = 100	REER	World Development Indicators & Federal Reserve Bank of St. Louis