Dynamic Relationship between Renewable Energy and Tourism Development: Evidence from the G20 Countries

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 both on the tourism revenues and tourist arrivals in the sample of 19 developing and developed economies of the G20 members. The annual data from 1995 to 2015 and the panel econometric techniques are utilized to achieve the objectives of our paper. The results for the long-run elasticities from the non-parametric approach suggest that renewable energy has a considerable positive impact on the tourism revenue and the tourist arrivals. Similarly, our results also imply that tourism investments positively contribute to the tourism revenue and the tourist arrivals. Given these results, we argue that promoting both renewable energy and tourism investments should be considered as the major driving forces of the tourism development in the G20 countries. Our paper also offers several important policy implications and adds value to the empirical literature.

Keywords: tourism development; tourism investments; renewable energy; environmental quality; panel data estimation techniques

JEL Classification Codes: Z32; Q42; C32

1. 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), 2016). In addition, international tourism generated United States Dollar (USD) 1.26 trillion earnings and 10% of the world's gross domestic product (GDP) in 2015 (UNWTO, 2016). The tourism sector has significant indirect and positive effects on economic performance, through the channels of adjusting the current account balance and accumulating foreign exchange reserves. Tourism also causes to increase new employment areas and tax revenues, lead to an increment of infrastructure investments and reduce the poverty (Blake et al., 2008). In addition, the tourism industry has direct and positive impacts on economic growth by enhancing the production level of goods and services. Overall, development of the tourism industry is marked as 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 (e.g. Dwyer et al., 2004; Lim, 1997; Oh, 2005; Song et al., 2012).

The above-mentioned significant improvement of the tourism industry is related to a hike in energy demand; and therefore, the development of tourism surges both the level of CO_2 emissions and energy consumption (Gössling and Peeters, 2015). The structure of energy consumption in the tourism consists of three main components: transportation, accommodation, and other activities (Beer et al., 2018). Indeed, tourism activities require a significant amount of energy consumption and most of it comes from fossil fuels. Given that fossil fuels are the main source of CO_2 emissions, the first theoretical underpinning is that the tourism activities can lead to a higher level of energy consumption and CO_2 emissions. A number of empirical papers (e.g. Scott et al., 2010) have confirmed this theoretical expectation. Given that the 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. To put it differently, the CO_2 emissions are considered as the main indicator of environmental degradation.

The second theoretical underpinning is if the energy requirement of tourism activities comes from the 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 that the renewable energy consumption plays 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 et al., 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 with implementing new technologies (power plants) (Otgaar, 2012). It is important to note that the investments in tourism sector can 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, our 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 the 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 the 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 et al., 2009; Shi et al., 2013; Yang, et al., 2008). All of these issues make it interesting to analyse the relationship between renewable energy and tourism activities, which is the subject of our paper.

Because of these reasons, potential determinants of growth of tourism industry are crucial. At this point, our paper aims to analyse the effects 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, it can reduce the tourism activities and tourism revenue. Therefore, we analyse whether the less-polluting countries (i.e. higher consumption of renewable energy) attract more tourists across the globe, and this is our main argument in the paper. Given that, we aim 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 (19 countries, excluding the European Union (EU)) for the period from 1995 to 2012. In addition, we further build our analysis based on the role of tourism investment (total investments in travel and tourism sector) on the tourism development. To the best of our knowledge, our paper is the first paper to analyse the effects of renewable energy consumption and tourism investments on the tourism development. Therefore, the findings derived from our paper will be very useful for the policy and practice. The detailed policy implications and contributions are discussed in the results section.

The remainder of the paper is organised as follows. Section 2 reviews the previous literature on the relationships among the renewable energy consumption, the tourism development, and the tourism investments. Section 3 explains the nature of the empirical model, the data, and the econometric methodology. Section 4 provides the empirical results and implements various robustness checks for the validity of the benchmark findings. Section 5 discusses the findings in detail and the potential policy implications. Section 6 provides the conclusion.

2. Literature Review

2.1. Effects of Tourism on CO_2 Emissions and Energy Consumption

The first theoretical expectation is that the tourism activities lead to a higher level of energy consumption and CO_2 emissions.[1] 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 the 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 the pollution. Becken and Simmons (2002) analyse the energy use of different sub-categories in tourism attractions and activities. They conduct a survey of 107 tourist attractions and business in New Zealand in 2000. They find that tourism activities are the significant determinant of energy consumption; thus, tourism activities can have the considerable impact on climate change. Their findings also indicate that flights (air travel) or jet boating activities positively affect the energy consumption in New Zealand. In another paper, Becken and Patterson (2006) estimate the level of CO_2 emissions related to the tourism industry in New Zealand in 2000. They indicate that the tourism industry needs a significant energy in the forms of fossil fuels and electricity. 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

[1] Banfi et al. (2005) empirically confirm that tourism contributes about 9 percent of the growth in gasoline sales in Switzerland. On the other hand, Bakhat and Rosselló (2011) investigate the contribution of tourism to the electricity consumption in the Balearic Islands of Spain. Based on the empirical findings, the authors argue that the tourism sector should not be treated as an energy-intensive sector.

significant carbon dioxide emissions due to the tourism-related activities. Tovar and Lockwood (2008) implement a qualitative analysis and find that the tourism sector is a significant driver of economic growth and environmental degradation in the rural region of Australia. Using the data in the year of 2006, Kuo and Chen (2009) find that the level of carbon dioxide emissions and energy consumption per tourist per trip positively related to the tourism-related activities (accommodation, recreation, and transportation) in Penghu Island, Taiwan. According to Scott et al. (2010), among others, the tourism industry is one of the significant determinants of the global climate change since the previous studies find that the development of tourism is positively related to the level of CO_2 emissions, which is the leading indicator of the environmental degradation across the globe.

Similarly, using the impulse-response analysis and the variance decompositions, Katircioglu (2014a) 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 error correction models and the Granger causality tests, Katircioglu et al. (2014) indicate that tourism development is positively associated with both the energy consumption and the level of CO_2 emissions in Cyprus. Considering the bottom-up approach, Tang et al. (2014) find that 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 et al. (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. Using the time-series approaches, Durbarry and Seetanah (2015) indicate that development of the tourism sector leads to higher CO_2 emissions in Mauritius over the period 1978–2011. Using the unit root test and the cointegration analysis with modelling the structural breaks, De Vita et al. (2015) indicate that tourism development positively affects both the energy consumption and the level of carbon dioxide emissions in Turkey over the period 1960–2009. Using three cointegration tests, the fully modified ordinary least squares (FMOLS) and the dynamic ordinary least squares (DOLS) estimations, Sharif et al. (2017) find that tourism development is positively associated with the level of carbon dioxide emissions in Pakistan for the period from 1972 to 2013.

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 emission 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). This hypothesis is also tested by various empirical papers. For example, using the panel unit root test, the panel cointegration analysis, and the fixed-effects estimations, Lee and Brahmasrene (2013) analyse the effects of tourism development on both economic growth and carbon dioxide emissions in the EU countries over the period 1988–2009. Their findings indicate that tourism development negatively affects the level of CO_2 emissions in the EU countries. Considering the cointegration and the Granger causality tests, Katircioglu (2014b) finds that tourism development negatively affects the level of CO_2 emissions in Singapore. Using the principal component analysis and the time-series analysis, Zaman et al. (2016) investigate the effects of both energy consumption and tourism development on CO_2 emissions in the panel dataset of 34 developed and developing countries for the period from 2005 to 2013. Their results demonstrate the causal evidence of tourism-induced CO_2 emissions in the considered sample countries. Zhang and Gao (2016) investigate the effects of tourism development on CO_2 emissions, economic growth, and energy consumption in the regions of China for the period from 1995 to 2011. Their findings indicate that tourism development negatively affects the level of CO_2 emissions in the Eastern region of China. There is also a long-run causal relationship that runs from tourism to CO_2 emissions.

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.

2.2. Effects of Energy Consumption and CO_2 Emissions on Tourism Development

There could also be a reverse causal relationship; i.e. CO_2 emissions and (renewable) energy consumption can drive the tourism indicators. The main idea of this hypothesis comes from the "direct", the "sustainability", and the "savings" effects that we have discussed in the introduction. At this point, a number of researchers have also investigated the effect of environment on tourism. For example, Bode et al. (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 the 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 sustainability of tourism development. Implementing the survey study for over 50,000 tourists in Chengdu (the capital city of Sichuan province in the Western China) over the period 1999–2004, Liu et al. (2011) find that the CO_2 emissions and energy consumption significantly affect the development of the tourism industry (tourism output) in Chengdu (the major tourist destination in Western China). 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. Using the input-output framework, Munday et al. (2013) analyse the effect of the carbon footprint on tourism consumption in Wales. They indicate that the carbon footprint is positively related to the tourism spending. Hoogendoorn and Fitchett (2018) argue that the 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 the renewable energy consumption on the 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, our 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 19 developing and developed (the G20) countries for the period from 1995 to 2012. The findings derived from our paper will add significant value to the body of knowledge on the role of renewable energy uses and tourism investments on tourism development. Furthermore, our paper provides substantial policy recommendations, which would be crucial for the policy and practice.

3. Model Specification, Data and Methodology

3.1. Empirical Models and Data

In this section, we describe the methodology that is used to investigate the dynamic association among the renewable energy consumption, the tourism development, and the tourism investments. The novelty of our paper is that it is the first paper to the best of our knowledge to provide an empirical analysis of the long-run effects of the renewable energy consumption and the tourism investments on the tourism development. The results can be useful in the context of designing and evaluating the importance of renewable energy sources as part of the sustainable tourism policy in the G20 economies.

Moreover, our paper also makes a methodological contribution by estimating the short-run causalities and the long-run estimates in a panel data setup. Our paper aims to achieve two main objectives: First, it aims to examine the effect of the renewable energy consumption on the tourism development; and second, it explores the impact of the tourism investment on the tourism development in the sample of the G20 countries. To achieve the first objective, we develop the following model:

$$\mathrm{TD}_{it} = \alpha + \beta_1 \mathrm{REER}_{i,t} + \beta_2\ \mathrm{PI}_{i,t} + \beta_3\ \mathrm{REC}_{i,t} + \beta_4\ \mathrm{TO}_{i,t} + \varepsilon_{i,t} \quad (1)$$

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)[2], 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.

In addition, we also aim to explore the impact of the tourism investment on the tourism development by applying the following specification:

$$\mathrm{TD}_{it} = \alpha + \beta_1 \mathrm{REER}_{i,t} + \beta_2\ \mathrm{PI}_{i,t} + \beta_3\ \mathrm{TI}_{i,t} + \beta_4\ \mathrm{TO}_{i,t} + \varepsilon_{i,t}$$

(2)

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

$$\mathrm{TA}_{it} = \alpha + \beta_1 \mathrm{REER}_{i,t} + \beta_2\ \mathrm{PI}_{i,t} + \beta_3\ \mathrm{REC}_{i,t} + \beta_4\ \mathrm{TO}_{i,t} + \varepsilon_{i,t} \quad (3)$$

$$\mathrm{TA}_{it} = \alpha + \beta_1 \mathrm{REER}_{i,t} + \beta_2\ \mathrm{PI}_{i,t} + \beta_3\ \mathrm{TI}_{i,t} + \beta_4\ \mathrm{TO}_{i,t} + \varepsilon_{i,t} \quad (4)$$

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).

3.2. Econometric Methodology

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

The long-run relationship among variables is examined through the panel cointegration methodology. Furthermore, we investigate the long-run effect of the renewable energy consumption on the tourism development by employing a non-parametric approach, i.e. the panel FMOLS estimation technique. Finally, we implement 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, we first analyze the unit root characteristics of our data through the use of panel unit root tests. More specifically, we employ three panel unit root tests such as the Levin, Lin and Chu (LLC) (2002), the Im, Pesaran and Shin (IPS) (2003) and the Augmented Dickey-Fuller (ADF) (Maddala and Wu, 1999; Choi, 2001) for identifying the order of integration of the variables.

Secondly, the long-run equilibrium relationship among the variables of interest is examined using the panel cointegration method. In our paper, we run the Fisher-type Johansen cointegration methodology. Unlike the conventional cointegration tests based on the Engle-Granger approach (Engle and Granger, 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, we can determine and identify the presence of cointegrating vectors. The panel cointegration technique is more suitable for our 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. We apply the nonparametric approach of the 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 and 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, we attempt to examine the dynamic bivariate causal relationships among the variables in a panel setup while taking into account of heterogeneity across countries. We apply 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. The unique nature of this test is that it takes into account of the heterogeneity regarding the logarithmic structure and unrestricted coefficients across the countries while testing the null hypothesis of no causal relationship in any country against the alternative hypothesis of a causal relationship for at least some countries. The test statistics were computed by taking the average of individual Wald statistics for each country, and it was proved that the panel test statistics converge to the normal distribution with time dimensions (*T*) and country dimensions (*N*) become infinity.

4. Empirical Findings and Discussion

4.1. Preliminary Analysis of the Data

We begin our preliminary analysis with the summary statistics on the selected variables of our sample countries. The summary statistics are displayed in Table 1.

[Insert Table 1 around here]

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, Japan, and Germany, respectively. Relatively, South Africa, Argentina, Saudi Arabia and Indonesia have lower tourism revenues. Similarly, France receives 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, Mexico, Argentina, and Russia. As expected, China, India, and the U.S. have highest renewable energy consumption (*REC*) among the G20 countries, whereas Saudi Arabia is the least renewable energy consumer. The average trade openness (*TO*) level is significantly higher in Korea, Saudi Arabia, and Canada, while it is lowest in Brazil and Japan. Finally, the countries like Australia, the U.S., Canada, and Japan have more than 40K USD GDP per capita (*PI*), whereas India has less than one thousand USD per annum. Overall, the G20 countries have more than 190 billion USD revenue from the tourism sector, while they also receive more than 20 million international tourists per year on average.

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

[Insert Table 2 around here]

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

4.2. Findings on Order of Integration of the Variables

To begin our empirical analysis, we first aim 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 our paper. For this reason, we employ three-panel unit root tests such as the LLC, the IPS, and the ADF. The LLC test functions by assuming common unit root 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.

[Insert Table 3 around here]

We estimate the LLC, the IPS and the ADF tests using the constant and the time-trend variables in the models. Our 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 is stationary at the levels. Hence, we apply these unit root tests again on the first order difference of the data series. Our unit root test findings confirm the rejection of the null hypothesis of a unit root for all of the variables at the first order differences. Given these results, we argue that our variables are integrated of order I (1). Many 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. We explore this in the following section.

4.3. Findings of Long-run Cointegration Relationship

Given the order of integration of our variables, which we confirm from the panel unit root tests, we investigate the long-run association among the variables of Eq. (1) and Eq. (2). To examine the cointegration relationship among the variables, we make use of the Fisher-Johansen panel cointegration test. The results of this test are reported in Table 4.

[Insert Table 4 around here]

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 the considerable long-run equilibrium association among the variables of the tourism development, the real effective exchange rates, the per capita income, the renewable energy consumption, and the trade openness. Similarly, the long-run association is also exist among the variables in tourism development, the real effective exchange rates, the per capita income, the trade openness, and the tourism investments. Given these results, we argue that the tourism development is significantly associated with the 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 have to pay attention to the promotion of renewable energy sources and tourism investments in these countries to witness the further expansion of the tourism industry.

4.4. Findings of Long-run Elasticities for Tourism Development

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 the tourism development, the renewable energy consumption, and the tourism investments. Hence, we apply the panel

FMOLS method to investigate the role of the renewable energy consumption and the tourism investments on the tourism development in the sample of the G20 countries. Most of the previous papers have argued that the FMOLS method uses the non-parametric framework to handle the issues of serial correlation and endogeneity that may possibly exist in our models. Therefore, the panel FMOLS methodology is a statistically robust technique to provide the stable long-run parameters. The findings of the FMOLS estimations are presented in Table 5.

[Insert Table 5 around here]

According to the results, a 1 percent growth in renewable energy consumption and tourism investment increases tourism development by 0.162 percent and 0.135 percent, respectively. The long-run elasticities from the Eq. (1) indicate that the renewable energy consumption, along with the per capita income significantly promote the tourism development in the G20 economies. Similarly, the long-run elasticities from the Eq. (2) show that the growth in tourism investments, the per capita income, and the trade openness positively contributes to the tourism development in the G20 countries, while the real effective exchange rates adversely affect the tourism development. These results show that the renewable energy consumption has the slightly higher impact on the tourism development than that of the tourism investments.

4.5. Robustness Checks of the Findings of Long-run Elasticities for Tourism Development

Furthermore, we undertake the additional analysis for the purpose of robustness analysis of the benchmark findings on the tourism development. More specifically, we investigate the long-run elasticities using the panel FMOLS models. We replace our dependent variable (tourism revenue) with another tourism indicator, such as the international tourist arrivals (*TA*). The purpose here is to see how the growth rates of the renewable energy consumption and the tourism investments affect the international tourist arrivals in the G20 countries.[3] The results of these models are disclosed in Table 6.

[Insert Table 6 around here]

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

4.6. Findings on Short-run Causal Relationships

Finally, our paper investigates the short-run causalities among the variables of the tourism development, the tourism investments, the renewable energy consumption, the trade openness, per capita income, and the real effective exchange rates. For this purpose, our 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.

[Insert Table 7 around here]

[3] 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. We did not report the results to save space, but they can be provided upon request.

We find the feedback association between the per capita income and the tourism investments. Similarly, the results also show one-way causality that runs from the per capita income to the tourism development. We also find the bi-directional causal relationship that runs from the tourism investment to the tourism development as well as from the tourism development to the tourism investment. Overall, the short-run findings on the causality imply that the per capita income causes the tourism investment and the tourism investment causes the tourism development. The tourism development also affects the tourism investment in return.

5. Discussion on the Findings and Policy Implications

Given the findings of our long-run estimations, we draw the number of policy implications, which are useful for the implementation of sustainable tourism development policies with respect to the G20 members. More specifically, our findings established that the growth in the renewable energy consumption positively contributes to the tourism development in terms of the tourism revenues and the 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, the 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 the renewable energy consumption helps to avoid the use of fossil fuel energy, which is more of carbon intensive. Consequently, promoting renewable energy helps to reduce the carbon dioxide emission levels in the country (Shi et al., 2013). The 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 inequalities. Given these arguments, policymakers should initiate more of sustainable tourism development policies, which may assist those countries to expand the tourism industry further.

Furthermore, our results indicate that the growth in tourism investments also positively contributes to the tourism revenues and the tourist arrivals in the G20 countries. These results imply that the tourism investments were playing an important role in promoting the tourism industry. The tourism investments might be helping 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, these sustainable tourism investments might be playing 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 the tourism revenue and the tourist arrivals, policymakers need to further introduce tourism investment policies, which should attract more investments into the tourism industry.

In addition, the growth in the per capita income and the trade openness also make a considerable contribution to the tourism development in the G20 countries. On the other hand, the growth in the real effective exchange rates adversely affects the tourism industry in the considered sample countries. For instance, an increase in income levels allows individuals to travel around and visit their preferred destinations around the world. Therefore, the growth in the per capita income not only increases international tourist arrivals, but also increases their spending on tourism-related activities. Similarly, increasing bilateral trade relations in terms of export and import of goods and services among the trading partners have also the substantial positive effect on the tourism development. For example, increasing business-related activities among the countries provide an opportunity for the business community to travel more often to their counter party countries. Consequently, the trade openness can have a substantial positive effect on the tourism development. Finally, the growth in the real effective exchange rates makes higher expensive for the travels, hence it adversely affects the growth in the tourism sector. Given these arguments, we suggest that policymakers, government officials, and travel agencies should realize the promoting role of the tourism investments and the use of renewable energy in the tourism industry in the G20 countries. Therefore, these authorities should make their efforts to initiate policies to promote the sustainable tourism investments and the policies related to the promotion and use of renewable energy sources. These policies may further assist those of the G20 economies to expand their tourism industry in their respective countries.

6. Conclusion

The G20 countries are considered as the major players in global tourism development. For instance, according to the UNWTO (2016) data, the G20 economies accounted 47 percent, 74 percent and 66 percent of the global international tourist arrivals, the tourism investments, and the tourism revenues in 2012, respectively. These statistics indicate the G20 countries play a significant role in the global tourism economy. The previous studies in the tourism literature have mainly focused on the effect of the tourism on economic development and the environment. However, it is not very clear to what extent the renewable energy consumption and the tourism investments promote the tourism development. For this purpose, our paper aimed to investigate the effects of the renewable energy consumption and the tourism investments on the tourism revenues and the tourist arrivals in the G20 countries. Using the annual data from 1995 to 2012, our 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.

Our empirical results showed that the renewable energy consumption played an important role in enhancing the tourism revenue and attracting the international tourist arrivals. The results also indicated that the tourism investments played a considerable role in the tourism development. These results implied that both the renewable energy consumption and the tourism investments are the important drivers of the tourism development in the G20 countries. Given these results, we argue that international tourists might have given more preferences to visit the countries that have less environmental pollutions. Therefore, the renewable energy consumption might be a driving force of the tourism development.

In addition, we argue that the tourism investments also played an important role to promote the tourism industry. For example, the tourism investments help to build attractive infrastructures, such as hotels, restaurants, travel vehicles, and other eco-friendly infrastructure such as energy efficiency, emission controlling technologies and access to renewable energy sources. In such a way, the tourism investments not only attract international tourists, but they also work effectively to reduce the adverse effect of the tourism industry on the environment.

Given these arguments, we suggest the policymakers of the G20 economies to initiate sustainable tourism policies in the form of the 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, our results are obtained from G-20 countries and this is the main limitation of our study. Therefore, future studies on the related subject can focus on other developing economies and developed countries in the panel dataset (e.g. the EU countries).

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Table 1.
Summary Statistics on Panel Dataset, 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
United Kingdom	240.65	26.80	15.82	139302.62	53.88	37557.24	114.48
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

Notes: TD - Total tourism contribution to GDP in billion US$; TA - International tourists arrival in millions; TI - Tourism investment in billion US$; 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
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
United Kingdom	0.80	2.47	7.37	11.28	0.71	1.54	0.87
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.

Table 3.
Results of the 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: 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 levels.

Table 4.
Results of the 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: Probabilities are computed using asymptotic Chi-square distribution; the estimated cointegration test models assume linear deterministic trend; *, ** & *** indicate rejection of the null hypothesis of no cointegration at the 10%, 5% and 1% significance levels, respectively.

Table 5.
Results of the Long-run Estimates Using Non-parametric 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

Note: *** indicate the significance levels at the 1%.

Table 6.
Robustness Check: Results of the Long-run Estimates Using Non-parametric 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

Note: * & *** indicate the significance levels at the 10% and 1%, respectively.

Table 7.
Results of the 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

Note: ** & *** indicate the significance levels at the 5% and 1%, respectively.