Energy Economics 83 (2019) 293–310

Contents lists available at ScienceDirect

Energy Economics

journal homepage: www.elsevier.com/locate/eneeco

Nexus between financial development, tourism, renewable energy, and greenhouse gas emission in high-income countries: A continent-wise analysis

Muhammad Tariq Iqbal Khan [a], Muhammad Rizwan Yaseen [b,*], Qamar Ali [c]

[a] Department of Economics, Government Postgraduate College, Jaranwala 37200, Pakistan
[b] Department of Economics, Government College University, Faisalabad 38000, Pakistan
[c] Department of Economics, Virtual University of Pakistan-Faisalabad Campus, 38000, Pakistan

ARTICLE INFO

Article history:
Received 28 November 2017
Received in revised form 4 July 2019
Accepted 22 July 2019
Available online 29 July 2019

JEL classification:
R1
Q5
Q4

Keywords:
AMG estimator
Financial development index
FGLS
Heterogeneity
D-H causality test

ABSTRACT

This study explained the nexus of GHG emission with tourism, financial development index, energy use, renewable energy, and trade in 34 high-income countries from three continents (Asia, Europe, and America) from 1995 to 2017. The Dumitrescu and Hurlin non-causality test established the feedback hypothesis for GHG and financial development (Europe); renewable energy and GHG (Europe); financial development and renewable energy (Europe); financial development and energy (Europe); tourism and energy (America); and trade and tourism (America). The uni-directional causality was observed from financial development to GHG (Asia, America); trade openness to GHG (Asia, Europe, America); tourism to GHG (Asia, Europe, America); trade to financial development (Europe); tourism to renewable energy (Europe); financial development to trade (America); financial development to tourism (America); trade to renewable energy (America); and tourism to renewable energy (America). The Parks' Feasible Generalized Least Square explored the reciprocal connection of GHG emission with financial development (Asia, Europe, America); renewable energy (Asia, Europe, America); trade in (Asia, Europe, America); and tourism (Europe). The Augmented Mean Group estimator showed a decrease in GHG due to financial development (Asia, America); renewable energy (Europe, America); and trade openness (Europe). A country-level reciprocal connection of GHG was detected with financial development in 11 countries, renewable energy in 22 countries, trade openness in 5 countries, and tourism in 12 countries. It is recommended to link the financial development with renewable energy and eco-friendly technologies by increasing the renewable energy in Asia and the financial development in America. It is also recommended to fix the mandatory target of renewable energy by establishment of renewable energy agency. Government should ensure efficient use of energy resources and should provide financial support to the eco-friendly projects at low interest rates. Government should promote environment-friendly tourism by using eco-friendly transportation in Asia and America. Government should increase the area under forest cover and promote eco-friendly products by using print, electronic, and social media. The importance of clean environment should be highlighted in the educational syllabus.

1. Introduction

The air pollution is responsible for many diseases such as heart disease, stroke, lung cancer, and respiratory diseases. In 2012, air pollution was accountable for approximately 7 million deaths in the world (Azam and Khan, 2016). The air pollution is also accountable for the infrastructure deterioration, natural resources damage, decrease in cultivation area and loss of human lives (Shahbaz et al., 2013a). During the 1980s, the discussion started to probe the nexus between environmental degradation and the economy (Azam and Khan, 2016). Carbon dioxide (CO_2) emissions contributed about 58.8% in total greenhouse gas (GHG) emission. The increase in GHG emission will be 52% by 2050 without the implementation of effective environmental policies (Sohag et al., 2017).

For the safety of the environment, the Kyoto Protocol agreement was introduced in 1997 to regulate the GHG emission in developed countries (Pao and Tsai, 2011; Apergis and Danuletiu, 2014). The countries showed reluctant behavior in this regard because it cost them in the form of less economic growth (Shahbaz et al., 2013a). Intensive energy use, economic growth, and industrialization were accountable for environmental degradation (Hossain, 2011). The sector of energy was accountable for approximately 61.4% of GHG (Khan et al., 2017) which emphasized the prestige of renewable energy because energy is required to improve the living standard (Apergis and Danuletiu, 2014), prosperity and economic growth (Sadorsky, 2009).

* Corresponding author.
E-mail address: rizwany2001@yahoo.com (M.R. Yaseen).

https://doi.org/10.1016/j.eneco.2019.07.018
0140-9883/© 2019 Elsevier B.V. All rights reserved.

Due to the inevitable nature of energy in production, it is essential to manage the resources of renewable energy. Renewable energy is safe, inexhaustible and clean than traditional energy. It is expected that renewable energy will occupy a driving position and surpass many conventional energy sources. The use of renewable energy increases by 8% annually, which indicate the environmental awareness among the public (Khan et al., 2017).

In the energy-environment nexus, tourism development is also important for sustainable economic growth (Zaman et al., 2016). Tourism is beneficial for the economy due to the provision of income, foreign exchange, employment, and infrastructure (Ali et al., 2018). Europe witnessed a rapid increase in tourism and received 39.5% of total tourists in 2014. Tourism in Europe is responsible for many benefits like jobs creation, foreign currency accumulation, a favorable balance of payments, and economic growth. However, tourism is blamed for pollution because the tourism industry was accountable for 5% of CO_2 emission in the world. Conversely, The United Nations Environment Programme (UNEP) stated the ability of tourism to reduce the CO_2 emissions if the tourism activities are planned with environment-friendly technology and transportation (Paramati et al., 2017).

The role of trade is vital for the promotion of environment-friendly technology (Khan et al., 2017). Trade is important for 'greening' the sector of energy because it has the ability to transfer renewable energy technology. Renewable energy is inevitable to fulfill the increasing demand for energy (Sebri and Salha, 2014). Trade openness is beneficial due to the efficient use of resources and advantages of economies of scale (Semancikova, 2016). Trade openness is also linked with the quality of the financial sector. The financial sector had direct as well as indirect association with economic growth (Pradhan et al., 2017).

Başarir and Çakir (2015) described the nexus between energy use, CO_2 emission, tourism, and financial development. The feedback causality hypothesis existed among tourism and financial development. Financial development has the ability for the reduction of GHGs with economic growth (Shahbaz et al., 2013a). Financial development is associated with the promotion of financial sector activities like expansion in foreign direct investment, stock market and banking activities (Sadorsky, 2011). It is beneficial for the economic growth, expansion in saving, increase in opportunities for business, increases in investment efficiency, technological development, and increase in the purchase of goods and services (Al-Mulali and Sab, 2012a; Sadorsky, 2011; Shahbaz and Lean, 2012). Developed countries have a proper financial system which put a direct impact on the economy (Menyah et al., 2014). Tamazian et al. (2009) pointed out the improvement in energy efficiency and working of enterprises after financial development which decreases the use of energy and also decreases the CO_2 emission. Tamazian and Rao (2010) mentioned that financial development created opportunities for modern technologies which are environmentally friendly.

Contrarily, the connection between financial development and CO_2 was positive (Sadorsky, 2010; Zhang, 2011) due to three factors (a) the enterprises purchase new machinery and start new projects after development in the stock market, accountable for more energy consumption and CO_2 emission (b) foreign investors find it feasible to invest and the foreign direct investment also leads to CO_2 emission and economic growth (c) consumers found a pleasure in loan activities and easiness in the buying of luxury goods like big residential places, automobiles, refrigerators, air conditioners, and others electronic items, accountable for CO_2 (Khan et al., 2018b).

"The climatic action" is one of the Sustainable Development Goals (SDG) defined by the United Nations (United Nations, 2018), for the protection of the environment and precious human lives. Therefore, this research intends to discover the nexus among GHGs, energy use, tourism, financial development, renewable energy, and trade in 34 HICs (Appendix A) in a multivariate framework. These countries were selected for the empirical analysis because Ertugrul et al. (2016) informed that the increase in CO_2 will be 127% in the developed countries by 2040. However, the per capita GHG emission was reduced by 12.16% in High-Income Countries (HICs) from 2000 to 2012 (WDI, 2018).

This contribution of study in the literature is described in five ways (a) it used the total GHG instead of only CO_2 emission (Table 1) as a proxy of environmental damage (b) it first time used the financial development index developed by IMF with the inclusion of various aspects of financial development (c) it first time perform the empirical analysis of 34 HICs by categorizing the panel of countries into three continent like Asian-HICs, European-HICs, and American-HICs (d) It first time includes the tourism in the nexus between energy, environment, and financial development (e) it separately explores the long-run GHG emission elasticity with respect to financial development, tourism, energy use, renewable energy, and trade in 34 HICs (f) it explores the four causality hypothesis in the case of selected HICs. The situation of the environment was represented by total GHG emission instead of CO_2 emissions because it represents a comprehensive picture of the environment. Total GHG emission includes various gases like carbon dioxide (CO_2), nitrous oxide (N_2O), perfluorocarbons (PFCs), methane (CH_4), hydrofluorocarbons (HFCs), and sulphur hexafluoride (SF_6). Due to this, recent studies (Wang et al., 2018; Sarkodie and Strezov, 2019; Sarkodie et al., 2019) used GHG emission to reflect the situation of the environment in the country.

This paper is planned as: Section 2 explored the published literature. Section 3 revealed the graphical and descriptive analysis of variables. Section 4 revealed the econometric methods involved in the empirical investigation. Section 5 discussed the results. Section 6 concluded the findings and highlighted the policy implications.

2. Review of literature

The research about the energy, environment, and economic growth is a vital area of research for the achievement of sustainable development. Therefore, many studies showed the nexus among economic growth, trade, energy utilization, financial development, renewable energy, and CO_2 emission (Table 1). The CO_2 increases due to rise in the use of energy (Al-Mulali and Sab, 2012b; Çetin and Ecevit, 2015; Abdallh and Abugamos, 2017; Nasreen et al., 2017), financial development (Boutabba, 2014; Al-Mulali et al., 2015a), economic growth (Shahbaz et al., 2013b; Al-Mulali et al., 2015a; Salahuddin et al., 2018), trade (Farhani et al., 2014; Al-Mulali and Ozturk, 2015), electricity use (Salahuddin et al., 2018). The decrease in CO_2 was found due to the increase in financial development (Shahbaz et al., 2013a; Al-Mulali et al., 2015b; Nasreen et al., 2017), and forest (Khan et al., 2018a), renewable energy (Al-Mulali et al., 2015a; Khan et al., 2018a), trade openness (Shahbaz et al., 2014; Al-Mulali et al., 2015a), and economic growth (Sadeghieh, 2016). It was found that energy was responsible for economic growth and financial development (Al-Mulali and Sab, 2012b). However, financial development (Rafindadi and Ozturk, 2016), technology, urbanization, economic growth (Shahbaz et al., 2017), tourism (Jebli et al., 2014; Dogan and Aslan, 2017) were responsible for the increase in energy demand. Renewable energy and trade were beneficial for the economy (Hassine and Harrathi, 2017).

The bi-directional causality was recognized for energy utilization and CO_2 (Al-Mulali et al., 2013a; Çetin and Ecevit, 2015), CO_2 and economic growth (Al-Mulali et al., 2015a; Ayeche et al., 2016), CO_2 and financial development (Ayeche et al., 2016), financial development and trade (Ayeche et al., 2016), CO_2 and trade (Jebli et al., 2015), economic growth and trade (Hassine and Harrathi, 2017), financial development and tourism (Başarir and Çakir, 2015), economic growth and energy use (Antonakakis et al., 2017), financial development and energy use (Gungor and Simon, 2017). The one-way causality was observed from financial development to CO_2 (Nasreen et al., 2017), energy use to CO_2, trade to energy use, economic growth to energy use (Farhani et al., 2014), economic growth to renewable energy (Jebli et al., 2015; Armeanu et al., 2017), economic growth to CO_2 (Farhani et al., 2014; Sadeghieh, 2016; Salahuddin et al., 2018), financial development to

Table 1
Findings of published research.

Author(s)	Variables	Countries	Method	Duration	Results
Al-Mulali et al. (2013b)	Energy utilization, CO_2 emission, and economic growth	Total 32 countries	CCR	1980–2008	1) Energy use ↔ CO_2 ↔ economic growth ↔ energy use (60% countries)
Jebli et al. (2014)	CO_2, tourism, economic growth, trade, renewable energy	Central and South America	ARDL, DOLS, FMOLS	1995–2010	1) Economic growth → trade & tourism; tourism → trade; renewable energy → trade & CO_2; 2) CO_2 ↔ tourism ↔ renewable energy ↔ CO_2 3) The emission level was reduced due to the rise in renewable energy and tourism.
Shahbaz et al. (2014)	Economic growth, electricity, CO_2, urbanization	UAE	ARDL, VECM	1975–2011	1) Result confirmed the inverted U-type connection among economic growth and CO_2 emission. 2) The CO_2 increases due to urbanization and reduced due to exports. 3) Electricity ↔ CO_2; economic growth, urbanization → CO_2
Al-Mulali et al. (2015a)	Renewable energy, GDP, financial development, urbanization, and CO_2	23 European countries	VECM, FMOLS	1990–2013	1) The CO_2 positively related to GDP growth, financial development, and urbanization. 2) CO_2 decreases due to trade and renewable energy. 3) GDP growth ↔ CO_2
Al-Mulali et al. (2015b)	GDP, financial development, trade openness, and CO_2	Total 129 countries	DOLS, VECM	1980–2011	1) The financial development was beneficial to mitigate environmental degradation.
Zaman et al. (2016)	CO_2 emission, health expenditures, tourism, economic growth, energy, and domestic investment	Total 34 countries	Principal component analysis (PCA)	2005–2013	1) The inverted U-shaped link was established among CO_2 and per capita income. 2) Tourism → CO_2; energy use → CO_2; domestic investment → CO_2; economic growth → tourism; domestic investment → tourism; health expenditures → tourism.
Antonakakis et al. (2017)	Real GDP, energy and its components, CO_2 emission	Total 106 countries	PVAR	1971–2011	1) The energy use impact was heterogeneous on the economy and CO_2 for various countries. 2) Economic growth ↔ energy use (bi-directional causality)
Chakamera and Alagidede (2017)	Access to water & sanitation, and economic growth	Sub Saharan Africa	PCA, GMM	2000–2014	1) The effect of infrastructure was positive for the economy. 2) Long-run quality effect is higher than the short-run. 3) Aggregate infrastructure → economic growth.
Dogan and Aslan (2017)	CO_2, tourism, energy use, and real income	European countries	DOLS, fixed effect model, FMOLS	1995–2011	1) Emission is directly related to energy use and inversely with tourism and real income. 2) Tourism → CO_2 3) Energy use ↔ CO_2 ↔ real income
Gamage et al. (2017)	CO_2, income, tourism, and energy use	Sri Lanka	ECM, DOLS, VECM	1974–2013	1) The EKC hypothesis was not validated. 2) The energy was responsible for environmental damage. 3) Tourism and renewable energy were found beneficial for the protection of the environment.
Jiang and Bai (2017)	Economic growth and energy use	EMD method	China	1953–2015	1) Economic growth ↔ energy use (short run) 2) Economic growth → energy use (long run)
Keho (2017)	Energy use, economic growth, CO_2 emission	59 countries	Quantile regression	1971–2011	1) The EKC hypothesis validated (Europe, America, and the Sub-Saharan region). 2) The CO_2 rises due to a rise in energy use.
Hassine and Harrathi (2017)	Renewable energy, real GDP, financial development, trade	Gulf Cooperation Council countries	VECM, FMOLS, DOS	1980–2012	1) Real GDP ↔ trade openness 2) Output was significantly affected by renewable energy, private sector credit, and exports. 3) Renewable energy and exports increase economic growth.
Shahzad et al. (2017)	CO_2, trade, financial development, energy use	Pakistan	ARDL bounds test	1971–2011	1) The inverted U-shaped link was detected among energy use CO_2. 2) CO_2 increases due to trade and financial development. 3) Energy use, trade, financial development → CO_2 4) Financial development ↔ energy use
Suresh et al. (2017)	Tourism, trade openness, and output	India	Frequency-domain causality	1993–2014	1) Tourism ↔ trade openness; tourism ↔ output; 2) Tourism showed a multiplier effect on the economy.
Tang and Ozturk (2017)	Tourism, capital stock, economic growth	Egypt	TYDL causality	1982–2011	1) Tourism ↔ economic growth. 2) Results validated the tourism-led growth hypothesis.
Sharif et al. (2017)	CO_2, tourism, economic growth	FMOLS, DOLS	Pakistan	1972–2013	1) Tourist arrival → CO_2 emission.
Sherafatian-Jahromi et al. (2016)	CO_2 emissions and tourism	Pooled mean group techniques	5 Southeast Asian countries	1979–2010	1) The cointegration was found among CO_2 and tourism. 2) Inverted U-shaped link exists for tourism and CO_2. 3) CO_2 increases due to the use of energy and economic growth.
Stamatiou and Dritsakis (2017)	CO_2, energy use, and economic growth	VECM	Italy	1960–2011	1) Economic growth → CO_2 & energy use 2) Energy use ↔ CO_2
Zoundi (2017)	CO_2, renewable energy, Income per capita, primary energy, population	25 African countries	GMM and DOLS	1980–2012	1) The positive relationship exists between income level and CO_2. 2) Renewable energy reduced the level of CO_2.
Ali et al. (2018)	Total reserves, trade, tourism, sanitation, financial development, and renewable energy	19 Asia Cooperation Dialogue (ACD) countries	VECM, FMOLS	1995–2015	1) Sanitation, renewable energy, and financial development explored the long-run causality. 2) Growth hypothesis (financial development → reserves); feedback hypothesis (sanitation ↔ total reserves). 3) Total reserves accumulate due to sanitation and tourism.

energy use (Boutabba, 2014), CO_2 to energy consumption, CO_2 to economic growth (Asumadu-Sarkodie and Owusu, 2016), trade to renewable energy, CO_2 to renewable energy (Jebli et al., 2015), tourism to trade, renewable energy to trade (Jebli et al., 2014), trade to tourism (Tariq et al., 2015). Tourism is beneficial for economic growth if we regulate tourism-related emission by promoting renewable energy (Ohlan, 2017). Renewable energy has the ability to eliminate emission due to financial development, trade, and economic growth (Işik et al., 2017).

The literature showed four causality hypotheses (a) growth hypothesis, which shows that one variable significantly impact on another variable or unidirectional causality from first to second variable (b) conservation hypothesis, which shows the uni-directional causality running from the second to the first variable (c) feedback hypothesis, which shows the two-way causality among two variables (d) neutrality hypothesis, which shows the absence of causality among the variables (Tugcu, 2014).

3. Theoretical framework, model specification, and data

3.1. Theoretical framework and model specification

This research aims to explore the nexus among financial development, energy consumption, renewable energy, trade openness, tourism, and GHG emission in Asia, Europe, and America. After a detailed investigation (Table 1), it was found that energy use was considered as a major factor behind environmental deterioration. The literature (Table 1) highlighted the benefits of renewable energy for the environment because renewable energy was safe and clean as compared to traditional sources. Therefore, the present study used both energy and renewable energy use as explanatory variables. Tourism is a direct source of foreign currency and a country can increase the level of foreign reserves by promoting tourism-related activities in the country. It was also found that tourism was accountable for 5% of CO_2 emission in the world. However, Paramati et al. (2017) pointed out the ability of tourism to control CO_2 emissions if the tourism activities are planned with environment-friendly technology and transportation. Due to this, tourism is also treated as an explanatory variable in the energy-environment nexus. The environment-friendly technology is important for renewable energy as well as the promotion of tourism, keeping in mind the protection of the environment. Trade openness is important for the promotion of environment-friendly technology. Trade has the ability to transfer renewable energy technology. Trade is also beneficial for the efficient utilization of resources. But, trade openness is also linked with the development of the financial sector. Financial development could reduce GHG emission with economic growth. Therefore, tourism, financial development, and trade are also treated as explanatory variables in the empirical analysis. The relationship between the variables is described by using the empirical equation, expressed below:

$$GHG_{it} = f(FD_{it}, EN_{it}, REN_{it}, OPEN_{it}, TOU_{it}) \tag{1}$$

where GHG shows the per capita GHG emission; FD shows the financial development index (0—100); EN shows the per capita energy use; REN shows renewable energy; OPEN shows the trade openness; TOU shows the tourism; t shows the time (1995–2017), and the subscript i denotes the cross sections (34 countries). For intuitive and appropriate results, the variables were converted into natural logarithmic form and the error term was incorporated in the model (Ali et al., 2019); thus, Eq. (1) becomes:

$$\begin{aligned} \ln GHG_{it} = \beta_{i0} + \beta_{1i}\ \ln FD_{it} + \beta_{2i}\ \ln EN_{it} + \beta_{3i}\ \ln REN_{it} \\ + \beta_{4i}\ \ln OPEN_{it} + \beta_{5i}\ \ln TOU_{it} + \varepsilon_{it} \end{aligned} \tag{2}$$

where β_0 shows the constant term; the symbols β_1, β_2, β_3, β_4, and β_5 represent the coefficients of explanatory variables; ε shows the error term.

3.2. Data and descriptive analysis

This study used panel data of total 34 HICs from 1995 to 2017. These countries were further categorized into three panels according to their continent. Therefore, 6 countries were selected from Asia, 23 from Europe and 5 from America (South and North). The selected variables were financial development index, energy use, renewable energy use, trade openness, tourism share in exports, and GHG emissions for the empirical analysis. Financial development is the relative ranking of countries according to the access, depth, and efficiency of their financial institutions and markets (IMF, 2018). The International Monetary Fund (IMF) developed a comprehensive and new index of financial development by using the complex and multidimensional nature of financial development. This financial development index includes both financial institutions and markets on the basis of access, depth, and efficiency. The financial development index ranges between 0 and 1, but it is converted between 0 and 100 in order to make it compatible with the selected variables.

Table 2 compares the descriptive statistics in the case of three panels, named Asian-HICs, European-HICs, and American-HICs. It showed the difference in descriptive statistics between these panels. Appendix A showed the country-wise mean values in order to evaluate the country with respect to selected variables.

The trend of variables was explored by Figs. 1–6 in order to check the overtime performance in the three panels. It is cleared that the European HICs showed an impressive reduction in GHG emission per capita but the situation was not appropriate for Asian HICs. Although, Asian HICs showed better financial development trend than other panels.

4. Econometric procedure

The econometric procedure has six steps: (a) cross-sectional dependence tests (b) slope homogeneity test (c) unit root analysis (c) cointegration analysis (d) Granger causality analysis (e) estimation of GHG elasticity in the short and long-run (f) diagnostic tests.

Table 2
Descriptive statistics in HICs.

Panel	Mean	Min.	Max.	Std. dev.	Data source
Financial development index (FD) (0–100)					
Asia	65.553	21.758	88.207	15.586	IMF (2018)
Europe	61.370	19.474	100.000	18.687	
America	42.785	8.887	88.782	23.486	
Energy use (EN) (kg of oil equivalent per capita)					
Asia	4007.002	1546.682	7370.653	1412.295	WDI (2018)
Europe	4144.555	1674.411	18,394.662	2569.415	
America	2607.936	728.863	8056.864	2477.617	
Renewable energy consumption (REN) (% of total)					
Asia	2.162	0.005	9.022	2.389	WDI (2018)
Europe	18.013	0.000	79.391	17.382	
America	23.882	4.514	59.935	14.784	
Trade openness (OPEN) (% of GDP)					
Asia	156.923	16.679	442.620	140.950	WDI (2018)
Europe	108.108	37.108	423.986	65.721	
America	60.594	19.772	166.699	41.369	
Tourism share in exports (TOUR) (% of total exports)					
Asia	4.055	1.102	12.709	2.303	WDI (2018)
Europe	10.234	1.858	47.245	8.674	
America	10.138	2.761	24.758	5.019	
GHG emission (GHG) (metric ton of CO_2 equivalent per capita)					
Asia	11.452	5.743	18.627	2.892	WDI (2018)
Europe	11.708	5.273	78.767	6.548	
America	10.304	2.940	24.741	6.605	

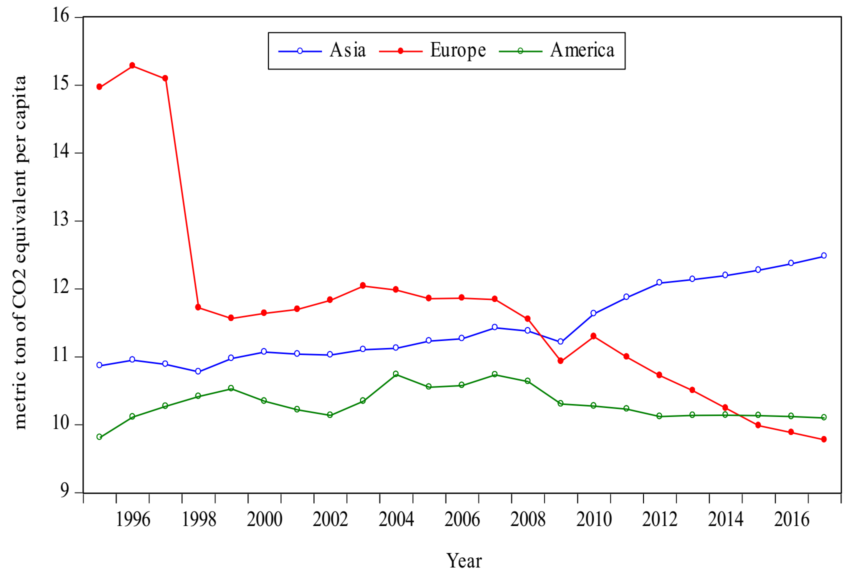

Fig. 1. GHG emission (1995–2017).

4.1. Cross-sectional dependence (CD) tests

The inspection of CD is the opening step in panel data analysis. It eliminates the means during correlation computation. This test used the null hypothesis (Rauf et al., 2018) that there is no CD in the data.

The CD test is empirically expressed as (Pesaran, 2004):

$$\mathrm{CD} = \sqrt{\frac{2T}{N(N-1)}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}\right)} \sim N(0,1)i,j \tag{3}$$

$$\mathrm{CD} = 1, 2, 3, 4.........65.......N \tag{4}$$

$$M = \sqrt{\frac{2T}{N(N-1)}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}\right)\frac{(T-k)\hat{\rho}^2{}_{ij}-E(T-k)\hat{\rho}^2{}_{ij}}{\mathrm{Var}(T-k)\hat{\rho}^2{}_{ij}}} \tag{5}$$

$\hat{\rho}^2{}_{ij}$ shows the residual pairwise correlation sample estimate which was estimated with the help of simple linear regression equation. The null hypothesis should be accepted if the panel data has no CD.

4.2. Slope homogeneity test

The next step is to reveal the homogeneity of the slope between the cross-sections. The assumption of homogeneity of the slope cannot capture the heterogeneity due to country-specific characteristics. The null and alternative hypothesis of slope homogeneity tests are (Chou, 2013):

Null hypothesis: H_o: $\beta_i = \beta$ for all i (cross-section)
Alternative hypothesis: H_1: $\beta_i \neq \beta_j$ for i ≠ j.

The null hypothesis is verified using the standard F test but it is applicable when (1) the time (T) is large, (2) cross-section (N) is small, (3) the independent variables are strictly exogenous, and (4) error variances are homoscedastic. Swamy (1970) proposed another slope homogeneity test by relaxing the homoscedasticity assumption. The standard F-test and Swamy test are applicable in panel data analysis when N is relatively smaller than T. Later, Pesaran and Yamagata (2008) give another slope homogeneity test (the Δ ~ test) for large panels. But, this test is valid when N and T approach to ∞. Xu (2018) highlighted the use of Swamy slope homogeneity test for small panels. A large chi-square statistic in Swamy test shows the heterogeneity of slope among the countries in the panel (Xu, 2018). The mathematical expression of the Swamy test is described as (Tong and Yu, 2018):

$$\tilde{S} = \sum_{t=1}^{N}\left(\hat{\beta}_i - \hat{\beta}_{WFE}\right)'\frac{X_i' M_\tau X_i}{\hat{\sigma}_i^2}\left(\hat{\beta}_i - \hat{\beta}_{WFE}\right) \tag{6}$$

where $\hat{\beta}_i$ represents pooled OLS estimator, $\hat{\beta}_{WFE}$ shows the weighted fixed effect pooled estimator, $M_\tau = I_T - Z_i(Z_i'Z_i)^{-1}Z_i'$ and $Z_i = (\tau_T, x_i)$, where τ_T is a $T \times 1$ vector of ones, x_i shows the explanatory variables, $\hat{\sigma}_i^2$ shows the estimator of the error variance.

4.3. Panel unit root tests

Due to CD, Rauf et al. (2018) suggested using parametric and non-parametric tests in order to explore the correct integration order. Due to statistical drawbacks of every test, Hossain (2011) also suggested using multiple tests. Therefore, this study employed five tests (a) Levin, Lin, and Chu (LLC, 2002) (b) Im, Pesaran and Shin (IPS, 2003) (c) Maddala and Wu (MW, 1999) (d) Choi (2006) (e) CIPS unit root test (Pesaran, 2007).

Persistence parameters ρ_i are common among cross section infers that $\rho_i = \rho$ for all i, is the fundamental assumption of LLC unit root test. But, its violation was observed for various variables. The cross-sectional independence should be held in the second and third test but it is also violated for income variable (Hossain, 2011). Moreover, Banerjee et al. (2001) explored the chances to over-reject the null hypothesis and poor size properties in the presence of CD. To encounter CD, Pesaran (2007) and Choi (2006) proposed a new test because the conventional tests were inappropriate due to CD. Therefore, the CIPS unit root test (Pesaran, 2007), called second-generation test was used for unit root analysis. This test has the ability to encounter the heterogeneity and CD.

4.4. Long-run cointegration tests

4.4.1. Westerlund panel cointegration test

The establishment of cointegration infers the possibility of minimum one uni-directional Granger causal relation. The order (1,1) co-integration was observed for two variables if these variables are non-stationary individually but their linear combination exhibited stationarity (Yaseen et al., 2018). Due to the presence of CD, it is appropriate to Westerlund (2007) cointegration test, called second-generation

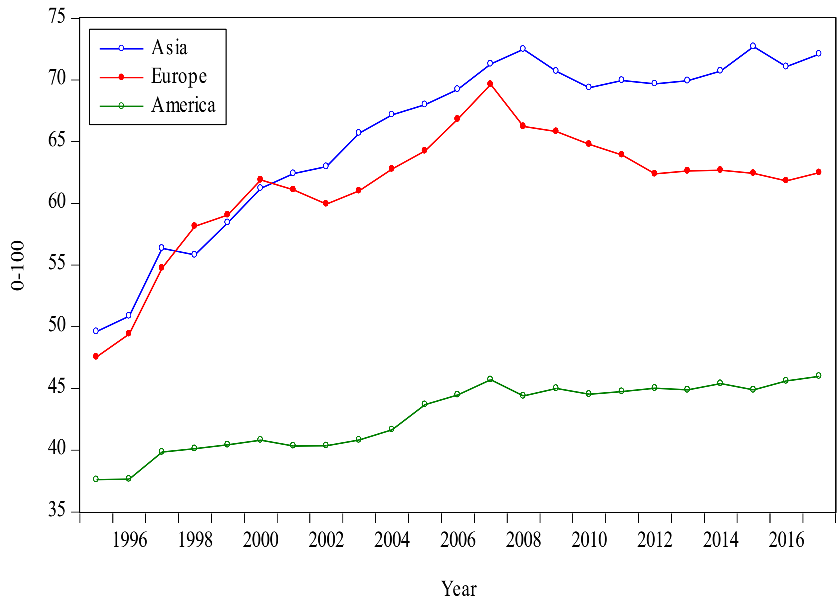

Fig. 2. Financial development index (1995–2017).

cointegration test. The bootstrapped versions of these tests have the ability to control the CD problem. Zhu et al. (2018) stated that the Westerlund cointegration test is a structural-based test, showed high power and accuracy as compared to the residual-based test like Pedroni (2004). The Westerlund test used error correction model to confirm the presence of cointegration. This test showed four statistics like Gt, Ga (group statistics), Pt, and Pa (panel statistics). The rejection of the null hypothesis for Ga and Gt implies the presence of cointegration in minimum one of the cross sections. Similarly, the rejection of the null hypothesis for Pa and Pt reveals the existence of cointegration in the panel, as a whole (Zoundi, 2017). Due to CD, the robust P-value has been estimated through 400 times of bootstrapping (Xu, 2018).

4.4.2. Hansen cointegration test (for time series analysis)

Lee and Chang (2005) highlighted the possibility of the volatile time trend for energy and economic variables. To avoid this problem, Hansen (1992) proposed another test of cointegration analysis, which was based on the full modified statistics. The null hypothesis of the Hansen test describes the presence of cointegration. The insignificance of test statistics is compulsory to confirm the long-run cointegration (Lee and Chang, 2005).

4.5. Panel causality test

After the confirmation of cointegration, it is required to detect the causality between the variables. Due to CD, the Dumitrescu and Hurlin (2012) test was used, which is based on the individual Wald statistic of Granger (1969) non-causality averaged across the cross-sections. The empirical model of this test is expressed as (Wang and Dong, 2019):

$$y_{it} = a_i + \sum_{j-1}^{J} \lambda_i^j y_{i(t-j)} + \sum_{j-1}^{J} \beta_i^j X_{i(t-j)} + e_{it} \tag{7}$$

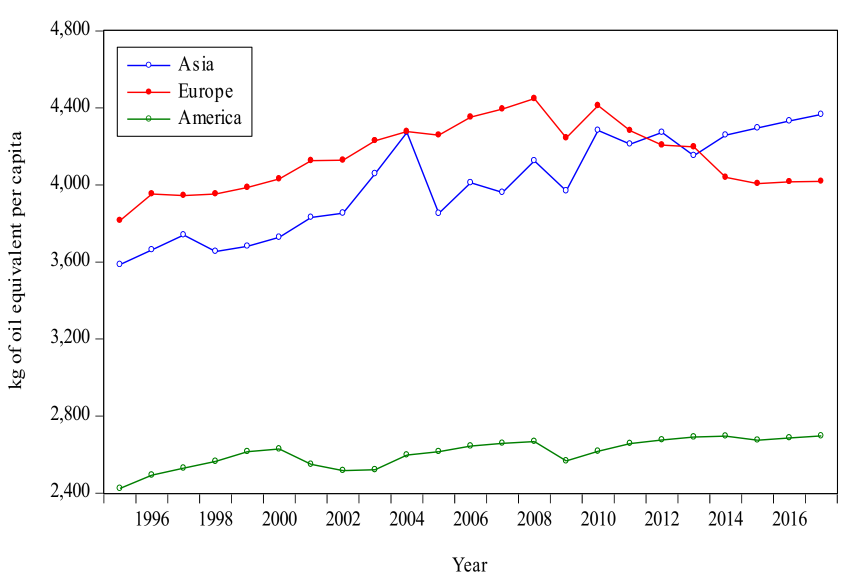

Fig. 3. Energy consumption (1995–2017).

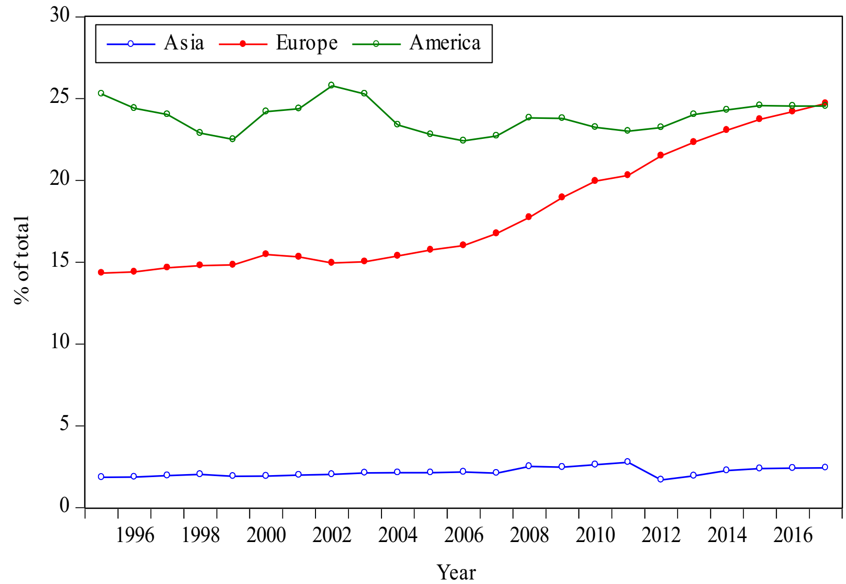

Fig. 4. Renewable energy consumption (1995–2017).

where y and x show observables; β_{ji} and λ_{ji} show the regression coefficient estimates and autoregressive parameters, respectively. These are supposed to change across countries (cross-sections). The null and alternative hypotheses are (Wang and Dong, 2019):

Null hypothesis: H_o: There is no causal association for any subgroup
Alternative hypothesis: H_1: There is a causal association for at least one subgroup.

The null hypothesis was tested with an average Wald statistic which is expressed as:

$$W_{N.T}^{HNC} = N^{-1}\sum_{t=1}^{N} W_{i,T} \tag{8}$$

where $W_{i,T}$ shows the individual Wald statistic for each cross-section.

4.6. Regression analysis

4.6.1. Fully modified ordinary least square (FMOLS)

The FMOLS (Aïssa et al., 2014) was used for the estimation of long-run elasticity coefficients. The FMOLS showed the ability to tackle endogeneity and serial correlation in the estimation of coefficients in panel data. This method is non-parametric and shows reliable parameters in small samples.

The mathematical expression for the panel FMOLS estimator is expressed as (Pedroni, 2001; Khan et al., 2017):

$$\hat{\beta}^*{}_{GFM} = N^{-1}\sum_{i=1}^{N}\hat{\beta}^*{}_{FM,i} \tag{9}$$

where $\hat{\beta}^*{}_{FM,i}$ is the FMOLS estimator applied to ith country, and the associated t-statistic is:

$$t_{\hat{\beta}^*_{GFM}} = N^{-1/2}\sum_{i=1}^{N} t_{\hat{\beta}^*_{FM,i}} \tag{10}$$

4.6.2. Dynamic ordinary least square (DOLS)

The DOLS method was first time recommended by McCoskey and Kao (1999) and Mark and Sul (2001). The DOLS is a parametric approach and shows the elasticity coefficient directly for a double-log model (Bilgili et al., 2016). This method has less biasness as compared to OLS and FMOLS in small samples by using Monte Carlo simulations. This method is used for the long-run analysis because it has the ability to encounter the issues of endogeneity and serial correlation (Herzer and Donaubauer, 2017). The present study used the DOLS method (Kao and Chiang, 2000), which is expressed as (Li et al., 2011; Alvarez-Ayuso et al., 2018):

$$y_{it} = \alpha + x_{it}\beta + \sum_{j=-q_i}^{q_2} c_{ij}\Delta x_{it+j} + v_{it} \tag{11}$$

where; Δx_{it} asymptotically eliminates the endogeneity of x_{it} on the distribution of OLS estimator of β, q_1 shows maximum lag length, q_2 shows maximum lead length, v_{it} shows a Gaussian vector error process.

4.6.3. Parks' feasible generalized least square (FGLS)

Reed and Ye (2011) mentioned that the FGLS is an estimator, which is used in the occurrence of heteroscedasticity, CD, and serial correlation in the panel. The general mathematical expression of coefficient and variables for the ordinary least squares (OLS) and FGLS estimators are expressed as:

$$\hat{\beta} = \left(X'\hat{\Omega}^{-1}X\right)^{-1} X'\hat{\Omega}^{-1}y \tag{12}$$

$$\mathrm{Var}\left(\hat{\beta}\right) = \left(X'\hat{\Omega}^{-1}X\right)^{-1} \tag{13}$$

where $\hat{\Omega}$ includes the assumptions about serial correlation, CD, and heteroscedasticity.

The FGLS (Parks) test required that the number of years is greater or equal to total cross-sections (Reed and Ye, 2011), and the condition ($N \le T$) holds in all three panels.

4.6.4. Augmented Mean Group (AMG) estimator

Wang and Dong (2019) revealed that the FMOLS ignores the CD in the panel and it is appropriate to use AMG estimator (Eberhardt and Bond, 2009) for the regression analysis. This test allows for CD by using the common dynamic effect parameter.

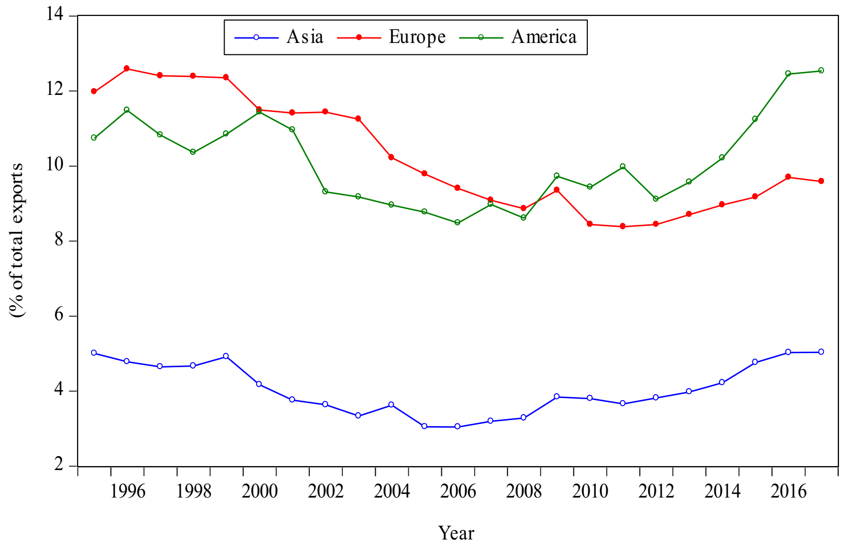

Fig. 5. International tourism (1995–2017).

The AMG estimation required a two-stage method (Wang and Dong, 2019):

AMG-Stage 1

$$\Delta y_{it} = \alpha_i + \beta_i \Delta x_{it} + \gamma_i f_t + \sum_{t=2}^{T} \delta_i \Delta D_t + \varepsilon_{it} \tag{14}$$

AMG-Stage 2

$$\hat{\beta}_{AMG} = N^{-1} \sum_{i=1}^{N} \hat{\beta}_i \tag{15}$$

where Δ shows the first difference operator; x_{it} and y_{it} shows observables; β_i shows the country-related coefficients; f_t shows the unobserved common factor with the heterogeneous factor; δ_i shows the coefficient of the time dummies and called as the common dynamic process; $\hat{\beta}_{AMG}$ shows the mean group estimator for AMG; α_i shows intercept, and ε_{it} shows the error term.

4.6.5. Error correction model (ECM)

Short-run GHG elasticity with respect to explanatory variables was estimated by using the ECM (Hossain, 2011):

$$\begin{aligned}\Delta\ \ln(\mathrm{GHG_{it}}) = {} & \alpha_1\Delta\ \ln(\mathrm{FD_{it}}) + \alpha_2\Delta\ \ln(\mathrm{EN_{it}}) + \alpha_3\Delta\ \ln(\mathrm{REN_{it}}) \\ & + \alpha_4\Delta\ \ln(\mathrm{OPEN_{it}}) + \alpha_5\Delta\ \ln(\mathrm{TOU_{it}}) + \lambda \mathrm{ECM_{it-1}} \\ & + \varepsilon_{it}\end{aligned} \tag{16}$$

where, ε_{it} shows the random error terms, α_1, α_2,α_3, α_4, α_5 represents the parameters, λ (coefficient of ECM) reflects the adjustment speed or annual convergence from short to the long-run equilibrium.

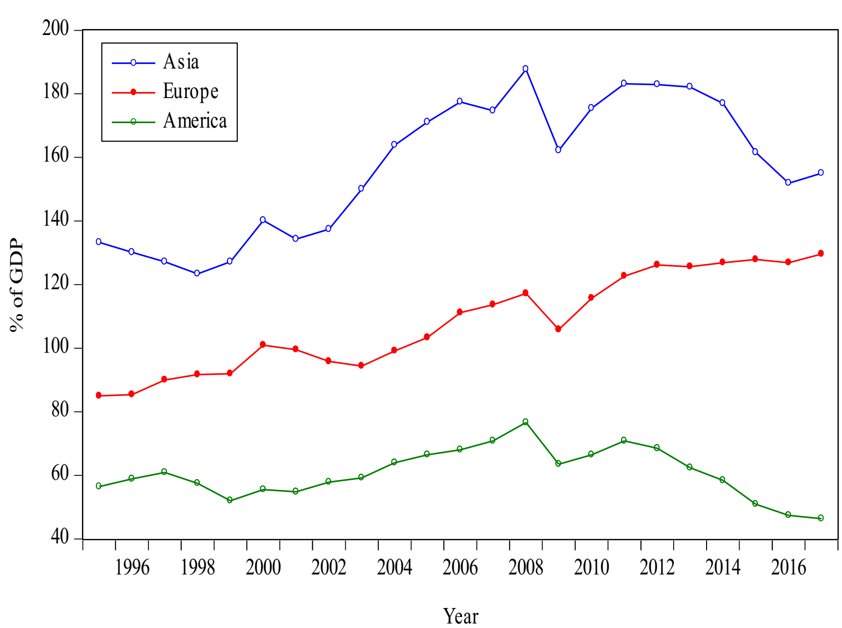

Fig. 6. Trade openness (1995–2017).

Table 3
CD and slope homogeneity test result.

	Asia		Europe		America	
	Test-stat.	Prob.	Test-stat.	Prob.	Test-stat.	Prob.
CD tests						
Pesaran CD	0.539	0.590	6.931[a]	0.000	−1.811[b]	0.070
Bias-corrected scaled LM	5.625[a]	0.000	45.038[a]	0.000	1.566	0.117
Pesaran scaled LM	5.761[a]	0.000	45.560[a]	0.000	1.680[b]	0.093
Slope homogeneity test						
Swamy (1970)	17.690[a]	0.003	50.220[a]	0.000	27.380[a]	0.000

[a] Significance level: 1%.
[b] Significance level: 10%.

Table 5
CIPS panel unit root test.

Variables		Case 1: Intercept & trend [at level]			Case 2: Only intercept [at first difference]		
		Asia	Europe	America	Asia	Europe	America
lnGHG		−2.590	−3.082[a]	−2.539	−4.715[a]	−4.914[a]	−4.068[a]
lnFD		−2.346	−2.881[a]	−2.406	−4.110[a]	−4.871[a]	−5.524[a]
lnEN		−2.739[c]	−2.975[a]	−3.032[b]	−5.079[a]	−4.615[a]	−4.440[a]
lnREN		−2.665	−2.862[a]	−2.823[c]	−4.967[a]	−5.085[a]	−4.595[a]
lnOPEN		−2.315	−1.771	−1.759	−3.734[a]	−3.322[a]	−4.168[a]
lnTOU		−1.645	−2.253	−2.650	−4.287[a]	−4.136[a]	−3.865[a]
Critical values	*1%*	*−3.10*	*−2.81*	*−3.10*	*−2.57*	*−2.30*	*−2.57*
	5%	*−2.86*	*−2.66*	*−2.86*	*−2.33*	*−2.15*	*−2.33*
	10%	*−2.73*	*−2.58*	*−2.73*	*−2.21*	*−2.07*	*−2.21*

[a] Significance level: 1%.
[b] Significance level: 5%.
[c] Significance level: 10%.

5. Results and discussion

5.1. Cross-sectional dependence (CD) and slope homogeneity test results

Table 3 reveals the presence of CD in the three panels. The presence of CD in the panels implies the use of CIPS test, 2nd generation cointegration test, D-H causality test, and AMG estimator for regression analysis. In the presence of CD, the Parks' FGLS estimator (Parks, 1967; Reed and Ye, 2011) was also appropriate for the long-run regression analysis. The slope homogeneity test implies the rejection of slope homogeneity hypothesis and confirmed the presence of slope heterogeneity in the panels.

5.2. Panel unit root test results

Table 4 reveals the unit root analysis by using two cases (a) at the level form (b) at the first difference form. The former case displayed diversified results about the stationary or nonappearance of a unit root. In Case 1, the stationary nature of all variables was not explored by all tests in three subgroups. According to case 2, all four tests revealed stationarity for all variables in three subgroups at first difference form. The lag length in unit root analysis was selected using the Schwarz automatic selection criterion.

The CIPS test (Table 5) explored mixed results at the level form but all the selected variables were stationary at first difference form. The Pedroni cointegration test was applied if the variables are stationarity at the first difference (Al-Mulali and Sab, 2012b). But, it is better to use second-generation cointegration test like Westerlund cointegration test (Westerlund, 2007) in the presence of CD.

5.3. Panel cointegration test results

The results (Table 6) confirmed the presence of cointegration in all three panels. The null hypothesis was rejected due to significant test statistics. It established the long-run association among the selected variables. The detection of cointegration implies the possibility of minimum one unidirectional Granger causal relationship.

5.4. Panel causality and regression analysis

The D-H non-causality test (Table 7; Fig. 7) and regression analysis (Table 8) was performed to explore the nexus of GHG emission with financial development, trade openness, tourism, energy use, and renewable energy use in HICs. The causality is observed among two variables when the present y value is predicted with the help of previous x values

Table 4
Panel unit root analysis for HICs.

Variables	Model 1: Intercept & trend [at level]				Model 2: Only intercept [at first difference]			
	LLC	IPS	MW	Choi	LLC	IPS	MW	Choi
Asian HICs								
lnGHG	−1.08	−0.37	18.72	−0.79	−10.36[a]	−9.43[a]	89.84[a]	−10.69[a]
lnFD	−1.10	−0.25	15.31	−0.36	−7.10[a]	−7.31[a]	67.93[a]	−6.97[a]
lnEN	−2.93[a]	−2.18[b]	22.01[b]	−2.60[a]	−14.70[a]	−13.60[a]	131.53[a]	−11.06[a]
lnREN	−12.87[a]	−11.42[a]	111.64	−13.41[a]	−15.65[a]	−13.16[a]	145.12[a]	−11.42[a]
lnOPEN	1.82	2.56	2.78	2.35	−9.19[a]	−7.32[a]	67.89[a]	−6.50[a]
lnTOU	0.62	1.72	3.56	1.64	−9.12[a]	−7.63[a]	71.38[a]	−6.73[a]
European HICs								
lnGHG	−4.68[a]	−3.05[a]	80.79[a]	−3.44[a]	−18.65[a]	−19.75[a]	379.18[a]	−19.41[a]
lnFD	−5.58[a]	−3.25[a]	75.88[a]	−2.74[a]	−14.49[a]	−13.97[a]	266.57[a]	−13.56[a]
lnEN	−3.22[a]	−0.17	58.46	−0.37	−20.22[a]	−18.13[a]	358.49[a]	−17.77[a]
lnREN	−2.84[a]	−2.10[b]	68.10[b]	−1.30[c]	−17.43[a]	−17.64[a]	334.27[a]	−18.12[a]
lnOPEN	−3.92[a]	−3.54[a]	80.42[a]	−2.13[b]	−16.83[a]	−15.95[a]	301.15[a]	−16.12[a]
lnTOU	−0.52	1.89	46.72	1.93	−16.54[a]	−15.47[a]	299.13[a]	−14.48[a]
American HICs								
lnGHG	−2.95[a]	−2.52[a]	21.78[b]	−2.03[b]	−9.74[a]	−8.25[a]	70.60[a]	−7.59[a]
lnFD	−4.27[a]	−5.32[a]	47.89[a]	−7.52[a]	−3.06[a]	−5.17[a]	50.28[a]	−8.31[a]
lnEN	−1.27	−1.36[c]	16.66[c]	−0.76	−8.34[a]	−7.60[a]	65.62[a]	−6.30[a]
lnREN	−1.92[b]	−0.39	10.15	−1.03	−9.85[a]	−8.32[a]	72.44[a]	−8.19[a]
lnOPEN	1.68	3.22	1.94	2.80	−8.11[a]	−6.62[a]	56.03[a]	−5.94[a]
lnTOU	0.33	0.80	11.18	2.08	−5.83[a]	−5.81[a]	49.13[a]	−5.33[a]

[a] Significance level: 1%.
[b] Significance level: 5%.
[c] Significance level: 10%.

Table 6
Westerlund panel cointegration test.

Statistic	Value	Z-value	P-value	Robust P-value
Asian HICs				
G_τ	−3.181[a]	−1.375	0.085	0.050
G_α	−8.065[a]	2.053	0.980	0.050
P_τ	−8.312[a]	−2.313	0.010	0.020
P_α	−9.014[a]	0.677	0.751	0.050
European HICs				
G_τ	−2.683[a]	−2.284	0.011	0.020
G_α	−7.264[b]	2.786	0.997	0.060
P_τ	−13.883[a]	−3.976	0.000	0.030
P_α	−6.595	0.866	0.807	0.110
American HICs				
G_τ	−1.560	1.402	0.920	0.653
G_α	−8.910	0.820	0.794	0.168
P_τ	−4.295	−0.072	0.471	0.270
P_α	−18.940[a]	−3.067	0.001	0.023

[a] Significance level: 5%.
[b] Significance level: 10%.

(Ali et al., 2019). There are three hypotheses of causality (growth, conservation, and feedback). For GHG, the growth hypothesis was established with trade openness (Asia, Europe, America), financial development (Asia and America), tourism (Asia, Europe, America). The growth hypothesis implies that these variables causes (either positive or negative) the GHG emission in their respective panel. It is useful for policy implementation because the change in financial development (Asia, America), trade (Asia, Europe, America), and tourism (Asia, Europe, America) may change the level of GHG emission. The conservation hypothesis established the causality from GHG to renewable energy in Asia, and from GHG to energy use in Europe. The feedback hypothesis explored the bi-directional causality between GHG and renewable energy; financial development and GHG in Europe. The feedback hypothesis infers that these variables cause each other in Europe.

Results (Table 8; Fig. 7) confirmed the nexus among financial development and GHG emission, which was uni-directional in Asia and America (from former to later) and bi-directional in Europe; while regression analysis confirmed the GHG reduction due to financial development in all three panels. In general, financial development is associated with the rise in energy utilization (Sadorsky, 2010, 2011; Shahbaz et al., 2013a; Islam et al., 2013; Zaidi et al., 2019) in multiple ways i.e. by increasing foreign direct investment, domestic capital investment, economic growth, and purchase of electronic items by the consumers (Shahbaz et al., 2018; Zaidi et al., 2019). This study also established the causality from financial development to energy use in Asia and America; and bi-directional between these variables in Europe. Boutabba (2014) also confirmed the causality from financial development to energy use. However, the link between financial development and environmental is either positive or negative.

The literature showed three kinds of relationship (a) reduction in the emission due to financial development (b) increase in the level of emission due to financial development (c) no significant relationship among these variables. This study supported the literature (a), showing

Table 7
Panel D-H test results for HICs.

No.	Null hypothesis (H_o)	Asian HICs			European HICs			American HICs		
		Coef.	P-value	Decision	Coef.	P-value	Decision	Coef.	P-value	Decision
1	FD ≠ GHG	5.780[c]	0.083	FD cause GHG	7.049[b]	0.015	FD cause GHG	4.062[c]	0.073	FD cause GHG
2	GHG ≠ FD	−0.804	0.605	No causality	5.203[c]	0.073	GHG cause FD	2.043	0.208	No causality
3	EN ≠ GHG	1.457	0.335	No causality	3.300	0.343	No causality	0.432	0.770	No causality
4	GHG ≠ EN	3.552	0.233	No causality	10.086[a]	0.008	GHG cause EN	2.386	0.283	No causality
5	REN ≠ GHG	1.458	0.328	No causality	7.990[b]	0.045	REN cause GHG	2.879	0.180	No causality
6	GHG ≠ REN	13.955	0.000	GHG cause REN	6.564[b]	0.043	GHG cause REN	1.753	0.345	No causality
7	OPEN ≠ GHG	3.950	0.100	OPEN cause GHG	5.946[c]	0.055	OPEN cause GHG	7.786[a]	0.013	OPEN cause GHG
8	GHG ≠ OPEN	−1.054	0.528	No causality	5.191	0.203	No causality	3.090	0.165	No causality
9	TOU ≠ GHG	6.413[c]	0.078	TOU cause GHG	5.406[b]	0.045	TOU cause GHG	3.562[c]	0.090	TOU cause GHG
10	GHG ≠ TOU	2.003	0.378	No causality	3.216	0.360	No causality	−0.260	0.838	No causality
11	EN ≠ FD	−0.016	0.995	No causality	5.245[c]	0.063	EN cause FD	2.115	0.233	No causality
12	FD ≠ EN	2.962[c]	0.100	FD cause EN	5.220[b]	0.040	FD cause EN	3.710[c]	0.068	FD cause EN
13	REN ≠ FD	−0.855	0.553	No causality	6.224[b]	0.033	REN cause FD	1.963	0.210	No causality
14	FD ≠ REN	1.367	0.385	No causality	4.133[c]	0.085	FD cause REN	1.086	0.533	No causality
15	OPEN ≠ FD	3.776	0.268	No causality	6.382[b]	0.035	OPEN cause FD	1.751	0.320	No causality
16	FD ≠ OPEN	0.790	0.663	No causality	0.597	0.815	No causality	3.811[c]	0.060	FD cause OPEN
17	TOU ≠ FD	2.053	0.210	No causality	1.754	0.558	No causality	−0.502	0.763	No causality
18	FD ≠ TOU	−0.757	0.645	No causality	−0.042	0.990	No causality	4.123[b]	0.045	FD cause TOU
19	REN ≠ EN	1.582	0.353	No causality	14.220[a]	0.000	REN cause EN	1.845	0.380	No causality
20	EN ≠ REN	23.133[a]	0.000	EN cause REN	6.526[b]	0.025	EN cause REN	2.256	0.330	No causality
21	OPEN ≠ EN	6.690[c]	0.078	OPEN cause EN	6.536[c]	0.053	OPEN cause EN	3.589	0.123	No causality
22	EN ≠ OPEN	1.561	0.328	No causality	2.046	0.525	No causality	4.930[c]	0.070	EN cause OPEN
23	TOU ≠ EN	7.482[b]	0.025	TOU cause EN	6.044[b]	0.038	TOU cause EN	4.363[c]	0.075	TOU cause EN
24	EN ≠ TOU	1.216	0.435	No causality	2.871	0.420	No causality	4.499[b]	0.045	EN cause TOU
25	OPEN ≠ REN	1.013	0.538	No causality	3.203	0.320	No causality	8.431[a]	0.008	OPEN cause REN
26	REN ≠ OPEN	1.660	0.320	No causality	7.471	0.135	No causality	1.063	0.483	No causality
27	TOU ≠ REN	−0.010	0.992	No causality	7.717[a]	0.008	TOU cause REN	3.685[c]	0.093	TOU cause REN
28	REN ≠ TOU	0.370	0.798	No causality	6.375	0.125	No causality	0.124	0.925	No causality
29	TOU ≠ OPEN	3.416	0.165	No causality	1.714	0.698	No causality	3.891[c]	0.100	TOU cause OPEN
30	OPEN ≠ TOU	1.044	0.578	No causality	4.099	0.223	No causality	14.859[a]	0.000	OPEN cause TOU

Causality hypotheses

		Asian HICs	European HICs	American HICs
1	Growth	FD, OPEN, TOU → GHG	OPEN, TOU → GHG	FD, OPEN, TOU → GHG
2	Conservation	GHG → REN	GHG → EN	
3	Feedback		FD ↔ GHG; REN ↔ GHG	

X ≠ Y means that X does not cause Y.
[a] Significance level: 1%.
[b] Significance level: 5%.
[c] Significance level: 10%.

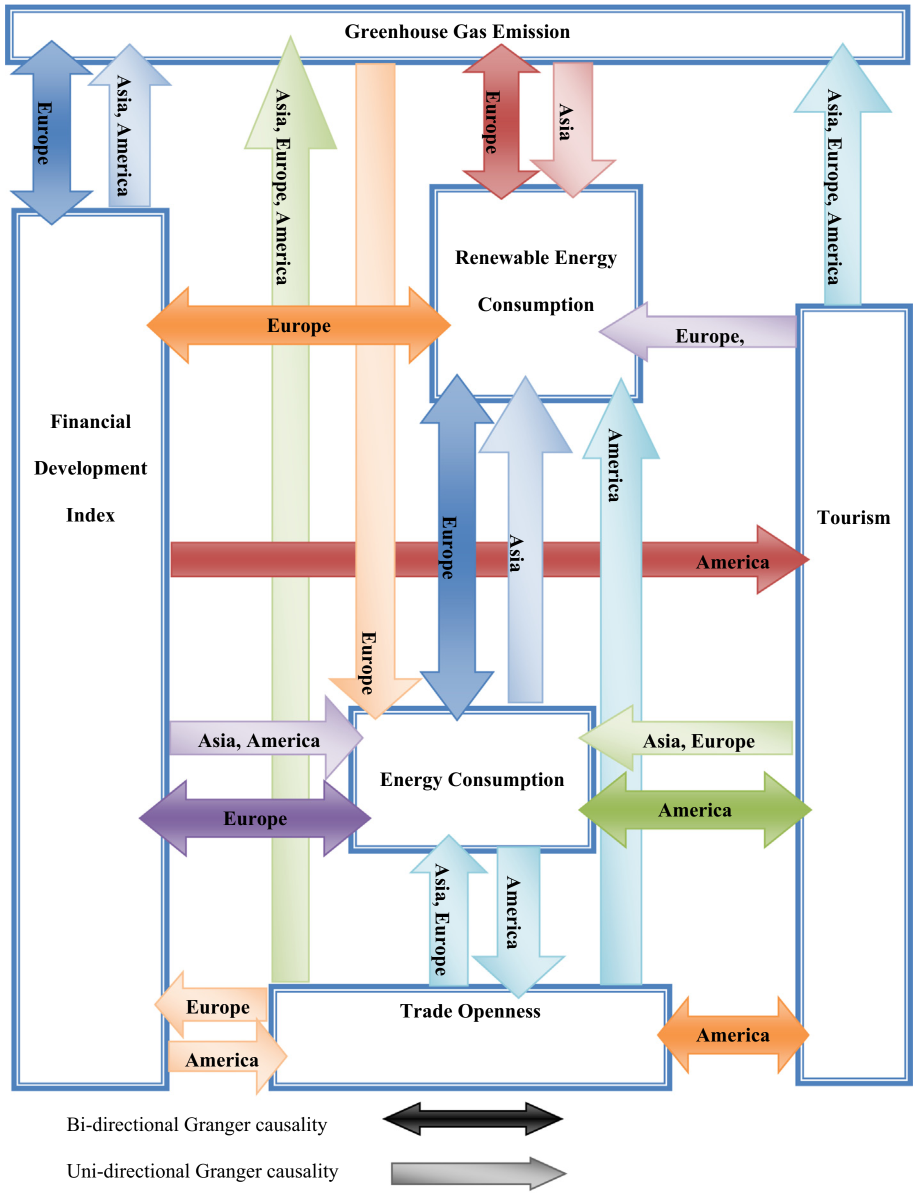

Fig. 7. Granger causality in HICs (by continent).

the environmental benefits of financial development in European countries (Shahbaz et al., 2018), Malaysia (Shahbaz et al., 2013b), Indonesia (Shahbaz et al., 2013c), and panel of 129 countries (Al-Mulali et al., 2015b). Further, Chang (2015) revealed the theoretical link behind the environmental benefits of financial development and highlighted that financial development is accountable for the increase in renewable energy and improvement in environment-friendly technologies. The literature about the association between GHG and financial development is rare but the inverse association between CO_2 and financial development was explored in the BRICS countries (Tamazian et al., 2009), China (Jalil and Feridun, 2011), Malaysia (Shahbaz et al., 2013c), South Africa (Shahbaz et al., 2013a), and top countries with respect to renewable energy attractiveness index (Dogan and Seker, 2016). Zaidi et al. (2019) showed a decrease in CO_2 by 0.0021% for 1% rise in financial development in the panel of Asia Pacific Economic Cooperation countries. It is essential to note that Zaidi et al. (2019) used only one indicator of financial development (domestic credit issued to the private sector) but we used a new indicator of financial development, which was recently introduced by IMF. Due to this fact, the size of mitigation impact i.e. 0.050% (Asia), 0.309% (Europe), and 0.543% (America) were greater in the present study, according to FGLS regression model. Hence, it is concluded that financial development leads to environmental stability in Asia, Europe, and America. However, it is possible when financial development is linked with the promotion of renewable energy and environment-friendly technologies and regulations. It is also interesting to note that the bi-directional causality was found among financial development and renewable energy use in Europe but no causality was found between financial development and renewable energy in Asia and America.

It is due to the fact that the average share of renewable energy was only 2.162% in Asia (Table 2) although the financial development index was 65.553. On the other hand (Table 2), the American countries had 23.882% consumption of renewable energy while their financial development index was low i.e. 42.785 as compared to Europe (61.370) and Asia (65.553). So, it is essential to raise the share of renewable energy in Asia and improvement in financial development index in America for the establishment of an environment-friendly link between financial development and renewable energy. The literature (Brunnschweiler, 2010; Hassine and Harrathi, 2017; Ji and Zhang, 2019) also revealed the advantage of financial development for the

Table 8
Regression results of GHG emission in HICs.

Variables	Asian-HICs		European-HICs		American-HICs	
	Coef.	Prob.	Coef.	Prob.	Coef.	Prob.
FMOLS cointegration regression (long-run)						
lnFD	−0.103[b]	0.019	−0.057[a]	0.021	−0.378[a]	0.008
lnEN	0.345[a]	0.000	0.357[a]	0.000	0.657[a]	0.000
lnREN	−0.009	0.608	−0.191[a]	0.000	0.015	0.797
lnOPEN	−0.022	0.468	0.071[b]	0.035	−0.430[a]	0.000
lnTOU	0.067[a]	0.000	−0.058[a]	0.000	0.087	0.145
FGLS regression model (long-run)						
lnFD	−0.050[c]	0.079	−0.309[a]	0.000	−0.543[a]	0.000
lnEN	0.361[a]	0.000	0.507[a]	0.000	0.759[a]	0.000
lnREN	−0.040[a]	0.000	−0.069[a]	0.000	−0.056[c]	0.070
lnOPEN	−0.093[a]	0.000	−0.038[a]	0.001	−0.379[a]	0.000
lnTOU	0.055[a]	0.000	−0.084[a]	0.000	0.026	0.260
DOLS cointegration regression (long-run)						
lnFD	−0.115[c]	0.067	−0.074[b]	0.040	−0.108	0.363
lnEN	0.342[a]	0.000	0.354[a]	0.000	0.354[a]	0.000
lnREN	−0.013	0.601	−0.218[a]	0.002	−0.243[a]	0.000
lnOPEN	−0.007	0.883	0.115[c]	0.055	0.105[b]	0.036
lnTOU	0.071[a]	0.001	−0.050[c]	0.060	0.030	0.338
AMG regression (long-run)						
lnFD	−0.261[a]	0.004	0.016	0.702	−0.135[a]	0.000
lnEN	0.375[a]	0.000	0.491[a]	0.000	0.573[a]	0.000
lnREN	−0.002	0.920	−0.116[a]	0.005	−0.084[a]	0.000
lnOPEN	0.065[c]	0.062	−0.033[c]	0.075	0.053[c]	0.087
lnTOU	−0.004	0.904	−0.033	0.255	0.048	0.185
ARDL error correction model (short-run)						
ΔlnFD	−0.053	0.259	0.014	0.764	−0.041	0.746
ΔlnEN	0.201[a]	0.000	0.457[a]	0.000	0.635[a]	0.002
ΔlnREN	−0.023	0.155	−0.086[c]	0.100	−0.094	0.431
ΔlnOPEN	0.024	0.494	0.035	0.442	−0.062[c]	0.091
ΔlnTOU	0.001	0.980	0.007	0.662	−0.101	0.226
ECM (−1)	−0.084[b]	0.016	−0.115[a]	0.003	−0.193	0.170

[a] Significance level: 1%.
[b] Significance level: 5%.
[c] Significance level: 10%.

promotion of renewable energy. The increase in renewable energy is required for the protection of the environment and conservation of conventional energy sources.

Therefore, the governments of these countries should ensure financial funding for the increase in renewable energy in the production process, which also stimulate economic growth. It is also recommended to ensure the efficient utilization of energy resources by the producers and consumers. It is beneficial to provide financial support to the environment-friendly project at low interest rates. Due to the availability of financial resources in HICs, it is recommended that the governments of these countries should provide green-technology to the developing countries at discounted rates. The environment pollution is a global issue and it is difficult for developing countries to adopt environment-friendly production techniques due to lack of financial resources. This study empirically supported the concept of reduction in environmental pollution for 1% rise in the renewable energy use in Asia (0.040%), Europe (0.069%), and America (0.056%), according to FGLS regression model. The bi-directional causality exists among renewable energy and GHG emission in the panel of European countries. Dogan and Seker (2016) added an interesting empirical study in the literature, showing the dynamics between real output, trade, renewable energy, financial development, and CO_2 emission in top renewable energy consuming countries. Dogan and Seker (2016) confirmed the reduction in CO_2 emission due to trade, financial development, and renewable energy use in the panel of 23 countries. This study also revealed the rise in GHG due to a 1% rise in energy use in Asia (0.361%), Europe (0.507%), and America (0.759%). It implies the policy formulation for the promotion of renewable energy. In this regard, Charfeddine and Kahia (2019) recently proposed some policies for the increase in renewable energy, like (a) fixing the mandatory target of renewable energy utilization, (b) establishment of renewable energy agency, (c) gradual reduction in the subsidies from conventional energy technologies, (d) inclusion of cost of externalities related to energy production in the prices. Therefore, it is recommended to increase the utilization of renewable energy (solar, wind, geothermal, hydropower, and biomass) in order to lessen the environmental damage due to the utilization of conventional energy sources.

The environmental damage due to the increase in tourism was also reported in the literature (Tovar and Lockwood, 2008; Scott et al., 2010; Nepal et al., 2019), because tourism is associated with the traveling and the use of fossil fuels in the motor vehicles. The use of fossil fuels is accountable for GHG emissions (Lee and Brahmasrene, 2013). This study confirmed the association between tourism and GHG emission, showing the uni-directional Granger causality from tourism to GHG in the three panels. Contrarily, Jebli et al. (2014) reported the bi-directional long-run causality among tourism and CO_2 emission. It is different from the findings of present research due to various reasons such as (a) measuring unit of tourism was different, which was number of tourist arrival instead of tourism share in exports, (b) use of CO_2 emission to reflect the environmental situation instead of GHG emission, which also includes hydrofluorocarbons (HFCs), nitrous oxide (N_2O), methane (CH_4), Sulphur hexafluoride (SF_6), and perfluorocarbons (PFCs), (c) use of VECM Granger causality test and ignoring the CD issue in the panel (d) the present study used the panel of 5 HICs from America (Argentina, Chile, Panama, United States, Uruguay) but Jebli et al. (2014) used the panel of 22 countries without considering their income group. The difference in the results implies that the situation was different when we categories countries with respect to the income group. It also implies that tourism causes GHG emission (either positive or negative) but GHG emission does not cause tourism. For the policymakers, the results of this study revealed that tourism promotion policies also affect the environment in the countries. Therefore, it is better to explore the direction (positive or negative) by using regression analysis, which revealed the increase in GHG (0.055%) for 1% increase in tourism in Asia but the reduction in GHG (0.084%) was observed for 1% increase in the tourism in Europe which was in line with Lee and Brahmasrene (2013) in the case of European Union (0.105%) due to adoption of low carbon economy policies. The tourism indirectly improves the environment in another way i.e. showing causal relationship towards renewable energy in Europe and America. Dogan and Aslan (2017) revealed the mitigation of emission due to tourism in European countries and suggested to promote bicycle-oriented and environment-friendly tourism, and the use of energy efficient and clean technologies. The association between GHG emission and tourism was not significant in America. Therefore, it is suggested to the governments of Asian and American countries to re-structure their tourism with respect to environmental protection like European countries. Lee and Brahmasrene (2013) pointed out another aspect of tourism and reported the significant role of tourism in economic growth due to the generation of employment, income, foreign reserves, and taxes. Chaisumpunsakul and Pholphirul (2018) mentioned the importance of trade for the economy and established its positive association with tourism. International trade attracts consumers in other countries, which leads to the promotion of tourism. International trade is also reported as a factor behind the international tourism demand.

Established the link between trade openness and environment, Park et al. (2018) reported the possible reasons behind the inverse relationship between trade and environmental pollution, which are; innovation of new technologies, adoption of high environmental standards, and shift of energy-intensive/polluted industry to developing countries, called as pollution haven hypothesis. This study showed the reduction in pollution for 1% rise in the trade openness in Asia (0.093%), Europe (0.038%), and America (0.379%), according to FGLS regression model. These results have support from Jebli et al. (2014) in Central and South American countries; Dogan and Seker (2016) in top renewable energy consuming countries; Park et al. (2018) in European Union countries. The trade openness and environment connection was also supported by the causality analysis, showing the uni-directional causality from trade to GHG in all three panels. Dogan et al. (2015) also reported that the increase in trade leads to the protection of the environment in OECD countries. Moreover, trade openness showed bi-directional causality with tourism in America. Dogan et al. (2015) described that trade openness is a positive externality of tourism. It is concluded that trade is beneficial for the economy and environment due to the establishment of a causal association with financial development, tourism, renewable energy, and GHG emission. Therefore, we recommended to the governments of these countries to increase the trade volume for the economic growth and environmental protection simultaneously.

5.5. The elasticity of GHG emission in Asia (country-wise analysis)

Table 9 shows the short and long-run GHG emission elasticity in Asian HICs. The country-wise empirical findings show a decrease in GHG due to 1% expansion in financial development (Hong Kong, Japan); renewable energy (Israel, Singapore); trade openness (Saudi Arabia); and tourism (Israel, Republic of Korea, Saudi Arabia). The GHG significantly rises due to 1% rise in financial development (Saudi Arabia); energy utilization (Hong Kong, Israel, Japan, Republic of Korea, Saudi Arabia, Singapore); renewable energy (Japan, Republic of Korea); trade openness (Japan); and tourism (Hong Kong, Singapore). The renewable energy is environment-friendly and the government should promote renewable energy for the clean environment. Xu et al. (2018) showed that the 1% rise in financial development (domestic credit to the private sector) was accountable for the 0.167% rise in CO_2 in Saudi Arabia. It is in line with this study, it showed the 0.134% rise in GHG emission for a 1% rise in financial development. It is due to the fact that the economy of Saudi Arabia is based on the oil sector and financial development increases the use of energy in the production process. Therefore, Xu et al. (2018) mentioned the need for environment-friendly technology.

In the short-run, the GHG showed a significant reduction due to financial development (Hong Kong, Republic of Korea); renewable energy (Israel, Saudi Arabia); trade openness (Republic of Korea); and tourism (Israel). The short-run rise in GHG was detected due to rise in financial development (Japan); energy use (Hong Kong, Israel, Republic of Korea); trade openness (Hong Kong, Israel, Japan); and tourism (Japan, Singapore). The ECM coefficient shows the percentage of yearly convergence from short to long-run equilibrium. Diagnostic tests showed the absence of heteroscedasticity and serial correlation. Diagnostic tests also confirmed the normality, structural stability, and presence of cointegration.

5.6. The elasticity of GHG emission in Europe (country-wise analysis)

Table 10(a)–(c) shows the short and long-run GHG elasticity in Europe. The GHG showed a fall due to 1% rise in financial development (Czech Republic, Denmark, France, Netherlands, Norway, Slovenia, United Kingdom); renewable energy (Czech Republic, Denmark, Finland, France, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland); trade (Hungry, Poland, Slovenia); and tourism (Denmark, Finland, Germany, Italy, Luxembourg, Malta, Netherlands, Norway, Poland, Slovenia, Sweden). The GHG rises due to a 1% rise in financial development (Croatia, Italy, Poland), energy use (Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom); renewable energy (Croatia, Malta); trade (Estonia, Greece, Italy, Norway, Spain); and tourism (Croatia, Slovak Republic). The emission reduction due to renewable energy was also explored by Başarir and Çakir (2015). In the short-run the GHG showed a fall due to financial development (Czech Republic, Germany, Hungry, Ireland, Norway); renewable energy (Croatia, Czech Republic, Denmark, Finland, Germany, Greece, Ireland, Luxembourg, Netherlands, Norway, Poland, Portugal, Spain, Sweden); trade (France, Hungry, Malta); and tourism (Germany, Luxembourg, Malta, Netherlands, Slovenia). The short-run rise in GHG was observed due to rise in financial development (Estonia, Poland, Slovak Republic); energy use (Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Malta, Netherlands, Poland, Slovak Republic, Slovenia, Sweden, Switzerland, United Kingdom); trade (Estonia, Italy, Norway); and tourism (Croatia, Ireland, Norway, Poland, Slovak Republic). The ECM coefficient

Table 9
Regression results of GHG emission for Asian HICs.

Variables	Asian-HICs					
	Hong Kong	Israel	Japan	Korea, Rep.	Saudi Arabia	Singapore
			FMOLS cointegration regression (long-run)			
lnFD	−0.359[a]	−0.020	−0.330[b]	−0.146	0.134[a]	0.066
lnEN	0.363[a]	0.309[a]	0.369[a]	0.394[a]	0.301[a]	0.331[a]
lnREN	−0.025	−0.055[a]	0.210[a]	0.097[a]	−0.046	−0.233[a]
lnOPEN	0.023	0.005	0.146[b]	−0.030	−0.102[c]	−0.172
lnTOU	0.408[a]	−0.064[a]	0.040	−0.066[b]	−0.060[a]	0.144[b]
			ARDL error correction model (short-run)			
ΔlnFD	−0.163[c]	−0.008	0.416[a]	−0.252[b]	0.014	0.107
ΔlnEN	0.396[a]	0.339[a]	−0.004	1.050[a]	0.074	0.019
ΔlnREN	−0.026	−0.025[b]	−0.047	−0.003	−0.024[a]	−0.023
ΔlnOPEN	0.191[a]	0.117[b]	0.184[a]	−0.085[b]	0.013	0.024
ΔlnTOU	0.055	−0.080[a]	0.028[c]	0.032	0.001	0.130[a]
ECM (−1)	−0.695[a]	−1.125	−0.505[a]	−0.543[b]	−0.259[a]	−0.317[a]
Diagnostic tests				**Test-statistic**		
LM Serial Correlation test	2.279	3.030	1.457	0.957	1.324	1.588
ARCH Heteroscedasticity test	0.003	0.031	1.363	1.161	0.007	2.594
BPG Heteroscedasticity test	0.332	0.779	0.303	0.957	1.311	1.726
Jarque-Bera Normality test	2.286	1.345	3.186	0.777	1.427	0.162
Durbin-Watson Stat	2.706	2.590	2.412	1.783	2.563	1.776
Hansen-Cointegration test	0.294	0.554	0.438	0.527	0.487	0.459
CUSUM Test				Stable		
CUSUM of Squares Test				Stable		

[a] Significance level: 1%.
[b] Significance level: 5%.
[c] Significance level: 10%.

Table 10
Regression Results of GHG emission for European HICs.

(a)

Variables	European-HICs							
	Croatia	Czech Republic	Denmark	Estonia	Finland	France	Germany	Greece
				FMOLS cointegration regression (long-run)				
lnFD	0.304[a]	−0.309[a]	−0.152[c]	0.257	0.008	−0.310[a]	−0.076	0.036
lnEN	−0.078[b]	0.419[a]	0.559[a]	−0.033	0.608[a]	0.549[a]	0.519[a]	0.246[a]
lnREN	0.099[c]	−0.193[a]	−0.339[a]	−0.063	−0.645[a]	−0.211[a]	−0.050	−0.151[a]
lnOPEN	0.101	0.148	−0.042	0.462[c]	−0.070	−0.151	−0.225	0.110[c]
lnTOU	0.184[b]	−0.007	−0.210[a]	0.014	−0.083[a]	−0.001	−0.343[c]	0.046
				ARDL error correction model (short-run)				
ΔlnFD	0.018	−0.192[a]	−0.157	0.757[a]	−0.006	0.036	−0.073[b]	0.360[a]
ΔlnEN	0.080	0.667[a]	0.963[a]	−0.285	1.291[a]	0.547[a]	0.337[b]	0.364[c]
ΔlnREN	−0.168[a]	−0.345[a]	−0.177[c]	1.007[a]	−0.506[a]	0.106[b]	−0.065[c]	−0.210[b]
ΔlnOPEN	−0.031	0.040	0.057	1.545[a]	0.001	−0.108[b]	0.099	−0.054
ΔlnTOU	0.091[c]	−0.048	−0.082	0.198	−0.064	−0.018	−0.226[a]	−0.025
ECM (−1)	−0.668[a]	−1.031	−0.481[b]	−0.964[a]	−0.438[a]	−0.207[a]	−0.425[a]	−0.245[a]
Diagnostic tests				**Test-statistic**				
LM Serial Correlation test	0.922	0.136	1.017	0.677	0.564	2.091	0.531	0.604
ARCH Heteroscedasticity test	0.160	0.160	0.026	1.361	0.810	0.086	0.223	0.240
BPG Heteroscedasticity test	1.208	0.136	0.821	1.797	0.928	0.489	1.035	1.714
Jarque-Bera Normality test	1.382	4.055	0.211	0.590	3.660	2.784	0.284	0.114
Durbin-Watson Stat	2.238	2.129	2.199	2.118	2.580	2.748	2.452	2.296
Hansen-Cointegration test	0.603	0.490	0.698	0.310	0.533	0.589	0.423	0.306
CUSUM Test				Stable				
CUSUM of Squares Test				Stable				

(b)

Variables	European-HICs							
	Hungary	Ireland	Italy	Luxembourg	Malta	Netherlands	Norway	Poland
				FMOLS cointegration regression (long-run)				
lnFD	0.049	−0.327	0.099[c]	−0.147	0.066	−0.228[a]	−0.637[b]	0.243[a]
lnEN	0.336[a]	0.527[a]	0.247[a]	0.536[a]	0.301[b]	0.494[a]	−0.093	0.313[a]
lnREN	−0.106[a]	−0.109[b]	−0.197[a]	−0.078[b]	0.022[a]	−0.167[a]	−0.202	0.011
lnOPEN	−0.139[b]	−0.042	0.138[c]	−0.074	−0.040	−0.082	1.758[b]	−0.206[b]
lnTOU	0.013	0.185	−0.156[b]	−0.242[b]	−0.104[b]	−0.051[a]	−0.406[a]	−0.056[c]
				ARDL error correction model (short-run)				
ΔlnFD	−0.196[a]	−0.388[a]	−0.033	0.319	−0.107	0.047	−0.287[b]	0.225[a]
ΔlnEN	0.364[a]	1.016[a]	0.401[a]	0.480[a]	0.135[b]	0.460[a]	0.036	0.494[a]
ΔlnREN	0.005	−0.103[c]	−0.011	−0.080[a]	0.008	−0.093[a]	−0.697[b]	−0.130[c]
ΔlnOPEN	−0.084[c]	−0.106	0.302[a]	−0.016	−0.272[a]	−0.007	0.797[a]	0.060
ΔlnTOU	0.029	0.211[b]	0.155	−0.188[a]	−0.078[a]	−0.032[b]	0.236[a]	0.056[c]
ECM (−1)	−0.337[a]	−0.456[b]	−0.373[a]	−0.555[a]	−0.113[a]	−0.584[a]	−0.127[a]	−0.882[a]
Diagnostic tests				**Test-statistic**				
LM Serial Correlation test	2.271	1.257	0.627	1.392	1.469	3.445[c]	2.067	1.839
ARCH Heteroscedasticity test	0.750	0.47	0.535	1.459	0.221	0.041	0.488	0.010
BPG Heteroscedasticity test	1.315	1.104	0.685	0.510	0.249	0.758	1.325	0.717
Jarque-Bera Normality test	0.836	0.489	1.300	1.598	1.503	0.762	0.381	3.049
Durbin-Watson Stat	2.424	2.384	1.760	2.520	2.603	1.877	2.921	2.175
Hansen-Cointegration test	0.451	0.530	0.727	0.322	0.414	0.192	0.455	0.162
CUSUM Test				Stable				
CUSUM of Squares Test				Stable				

(c)

Variables	European-HICs						
	Portugal	Slovak Republic	Slovenia	Spain	Sweden	Switzerland	United Kingdom
			FMOLS cointegration regression (long-run)				
lnFD	0.080	0.129	−0.087[b]	0.094	0.101	−0.078	−0.423[a]
lnEN	0.316[a]	0.235[a]	0.533[a]	0.258[a]	0.515[b]	0.353[a]	0.573[a]
lnREN	−0.499[a]	−0.125[a]	−0.108[a]	−0.300[a]	−0.745[a]	−0.193[a]	−0.049
lnOPEN	0.071	0.003	−0.156[a]	0.152[c]	0.047	−0.013	−0.121
lnTOU	0.182	0.087[b]	−0.265[a]	−0.076	−0.145[c]	0.052	0.041
			ARDL error correction model (short-run)				
ΔlnFD	0.037	0.274[a]	−0.031	0.124	0.088	−0.094	0.005
ΔlnEN	0.819	0.471[a]	0.669[a]	0.274	0.496[a]	0.314[b]	0.783[a]
ΔlnREN	−0.344[b]	0.013	−0.053	−0.182[a]	−0.543[a]	−0.057	0.026
ΔlnOPEN	0.191	0.085	−0.112	0.098	0.232	0.131	0.003
ΔlnTOU	0.278	0.040[c]	−0.164[b]	−0.100	−0.022	0.111	−0.079
ECM (−1)	−1.048	−0.329[a]	−0.656[a]	−0.461[b]	−0.376[b]	−0.159[a]	−0.474[a]
Diagnostic tests				**Test-statistic**			
LM Serial Correlation test	0.414	0.603	0.977	0.176	2.811	0.610	0.902
ARCH Heteroscedasticity test	0.508	0.477	0.909	0.050	0.163	0.103	0.267
BPG Heteroscedasticity test	0.362	1.326	0.727	0.378	0.257	0.794	1.610

Table 10 (*continued*)

(c)

Variables	European-HICs						
	Portugal	Slovak Republic	Slovenia	Spain	Sweden	Switzerland	United Kingdom
Jarque-Bera Normality test	2.461	0.822	0.579	0.344	0.119	1.757	2.335
Durbin-Watson Stat	1.846	1.954	1.883	1.906	2.643	2.059	2.433
Hansen-Cointegration test	0.360	0.719	0.216	0.725	0.624	0.337	0.384
CUSUM Test				Stable			
CUSUM of Squares Test				Stable			

[a] Significance level: 1%.
[b] Significance level: 5%.
[c] Significance level: 10%.

shows the percentage of annual convergence. Diagnostic tests showed the absence of heteroscedasticity and serial correlation, confirmed the normality, structural stability, and cointegration.

The country-wise results for the increase in financial development are in line with the findings of literature in Croatia (Park et al., 2018); Czech Republic (Park et al., 2018); France (Shahbaz et al., 2018). The country-wise results for the increase in trade openness are in line with the findings of literature in Hungary (Park et al., 2018); Slovenia (Park et al., 2018).

5.7. The elasticity of GHG emission in America (country-wise analysis)

Table 11 shows the short and long-run GHG emission elasticity in America. The analysis explored a significant decrease in GHG emission due to 1% rise in financial development (Argentina, Uruguay); renewable energy (Argentina, Chile, Panama, United States); trade openness (United States); and tourism (United States). The GHG significantly rises due to 1% more energy utilization (Argentina, Chile, United States, Uruguay); trade openness (Argentina, Uruguay); and tourism (Argentina).

In the short-run the GHG showed a significant fall due to financial development (Chile, Uruguay); renewable energy (Chile, United States, Uruguay); trade openness (Argentina, United States); and tourism (Argentina, Chile, Uruguay). The short-run rise in GHG was detected due to the rise in financial development (United States); energy use (Argentina, Chile, Panama, United States). The significant and negative ECM coefficient shows the percentage of yearly convergence from short to long-run equilibrium. Diagnostic tests showed the absence of heteroscedasticity and serial correlation. Diagnostic tests also confirmed the normality, structural stability, and presence of cointegration.

In America, the country-wise results for the increase in trade openness are in line with Dogan and Turkekul (2016) in the United States.

6. Conclusions and policy implication

This research demonstrated the long-run cointegration among financial development index, tourism share in exports, energy use, renewable energy, trade, and per capita GHG emission in 34 HICs from Asia, Europe, and America. The Dumitrescu and Hurlin non-causality test confirmed the uni-directional causality from financial development to GHG (Asia, America) but causality was bi-directional in Europe. The regression analysis confirmed the GHG reduction for 1% increase in financial development in Asia (0.050%), Europe (0.309%), and America (0.543%). So, the policymakers should focus on financial development and linked it with the promotion of renewable energy and eco-friendly technologies. It is important to note that the financial development established bi-directional causality with renewable energy in Europe. The Asian countries should raise the share of renewable energy

Table 11
Regression results of GHG emission for American HICs.

Variables	American-HICs				
	Argentina	Chile	Panama	United States	Uruguay
FMOLS cointegration regression (long-run)					
lnFD	−0.260[b]	−0.034	−0.136	0.031	−0.118[b]
lnEN	0.336[a]	0.425[a]	0.255	0.469[a]	0.251[a]
lnREN	−0.065[a]	−0.591[a]	−0.284[a]	−0.236[a]	0.040
lnOPEN	0.168[a]	0.205	0.134	−0.102[c]	0.167[a]
lnTOU	0.200[a]	−0.029	0.137	−0.187[a]	0.026
ARDL error correction model (short-run)					
ΔlnFD	−0.037	−0.336[b]	−0.020	0.205[b]	−0.063[b]
ΔlnEN	0.754[a]	0.299[b]	0.773[a]	0.954[a]	−0.046
ΔlnREN	−0.038	−0.806[a]	0.349[b]	−0.060[c]	−0.185[a]
ΔlnOPEN	−0.102[b]	0.132	0.133	−0.190[a]	0.036
ΔlnTOU	−0.116[c]	−0.184[b]	−0.065	0.008	−0.032[c]
ECM (−1)	−0.358[a]	−0.983[a]	−0.422[a]	−0.281[a]	−0.123[a]
Diagnostic tests	**Test-statistic**				
LM Serial Correlation test	0.303	2.494	1.712	1.274	1.371
ARCH Heteroscedasticity test	0.274	0.461	0.002	0.066	0.092
BPG Heteroscedasticity test	0.942	0.634	0.487	0.935	0.560
Jarque-Bera Normality test	0.470	3.418	0.063	0.877	3.037
Durbin-Watson Stat	2.091	2.357	2.827	3.104	2.681
Hansen-Cointegration test	0.537	0.620	0.677	0.681	0.312
CUSUM Test	Stable				
CUSUM of Squares Test	Stable				

[a] Significance level: 1%.
[b] Significance level: 5%.
[c] Significance level: 10%.

because it was only 2.162% in Asia while American countries should improve the financial development index because it was only 42.785 in America. This study revealed the rise in GHG due to a 1% rise in energy use in Asia (0.361%), Europe (0.507%), and America (0.759%) but the reduction in GHG was observed for 1% rise in the renewable energy in Asia (0.040%), Europe (0.069%), and America (0.056%). So, the policymakers in Asian and American countries should link the financial development and renewable energy for the clean environment. For the promotion of renewable energy (solar, wind, geothermal, hydropower, and biomass), it is recommended to fix the mandatory target of renewable energy in total energy mix, establishment of renewable energy agency, reduction in the subsidies for conventional energy technologies, and inclusion of externalities cost related to energy production in the prices. It is also recommended to ensure the efficient use of energy resources in the production process by the provision of financial support to the environment-friendly project at low interest rates. It is recommended that the governments of HICs should provide green-technology to the developing countries at discounted rates. This study confirmed the uni-directional Granger causality from tourism to GHG in the three panels. The increase in GHG was 0.055% for 1% increase in tourism in Asia but the reduction in GHG was 0.084% due to 1% increase in the tourism in Europe. The tourism indirectly improves the environment in another way i.e. showing causal relationship towards renewable energy in Europe and America. Tourism is directly linked with the accumulation of foreign reserves, which shows the financial strength of a country. The governments should re-structure their tourism in accordance with the environment and earn foreign reserves for financial development and technological progress. It is recommended to the governments of Asian and American countries to promote environment-friendly tourism by using eco-friendly transportation. For the protection of the environment, it is also suggested to invest in the innovation of new technologies and the implementation of high environmental standards. For the protection of the environment, it is suggested to enhance the trade of environment-friendly products and technology. This study showed the reduction in GHG for 1% rise in the trade openness in Asia (0.093%), Europe (0.038%), and America (0.379%). Moreover, the unidirectional causality was established from trade openness to GHG in all three panels. So, governments should reduce the tariff of environmentally friendly technology. It is highly recommended to increase the area under forest cover because trees are a natural absorber of CO_2 emission. It is also important to promote eco-friendly products by using print, electronic, and social media. The government should include the lessons in the educational syllabus about the importance of a clean environment. The empirical analysis of individual countries supported the results of their continent. The country-wise significant fall in GHG was detected for 1% growth in the financial development in 11 countries; renewable energy in 22 countries; trade openness in 5 countries; and tourism in 12 countries.

Acknowledgment

We would like to thank the editor and the two anonymous referees for their constructive comments and suggestions, which have significantly improved the manuscript.

Appendix A. Country-wise mean of selected variables (1995–2017)

Countries	Continent	Financial development index (0–100)	Energy consumption (kg of oil equivalent/capita)	Renewable energy consumption (% of total)	Trade openness (% of GDP)	Tourism share in exports (% of total exports)	Greenhouse gas emission (metric ton of CO_2 equivalent per capita)
Argentina	America	33.614	1790.139	10.286	30.668	7.838	8.984
Chile	America	45.543	1786.849	29.962	64.106	4.520	6.405
Croatia	Europe	33.464	2014.346	28.621	81.160	37.524	6.733
Czech Republic	Europe	36.565	4122.984	9.361	118.198	8.003	14.131
Denmark	Europe	66.752	3427.124	18.345	89.585	4.426	12.047
Estonia	Europe	34.222	3952.738	21.544	143.382	13.379	16.550
Finland	Europe	60.967	6416.410	33.693	73.760	4.195	14.729
France	Europe	71.778	4021.712	10.726	54.592	8.407	8.480
Germany	Europe	73.555	4017.624	7.928	69.968	3.662	12.151
Greece	Europe	55.169	2443.255	10.344	53.503	27.321	10.061
Hong Kong SAR, China	Asia	72.457	1965.556	0.767	330.065	4.983	7.377
Hungary	Europe	45.459	2511.266	9.058	138.036	9.128	7.011
Ireland	Europe	72.760	3217.901	4.460	171.603	4.172	15.944
Israel	Asia	53.728	2874.224	5.927	68.153	7.679	10.365
Italy	Europe	73.861	2872.413	9.665	50.978	8.414	8.845
Japan	Asia	76.979	3826.910	4.444	26.418	1.934	11.206
Korea, Rep.	Asia	77.746	4498.553	1.295	77.941	3.369	12.002
Luxembourg	Europe	74.449	7854.290	4.593	301.747	6.014	24.942
Malta	Europe	55.947	1936.334	1.343	257.757	15.582	7.680
Netherlands	Europe	76.535	4738.843	3.372	130.852	3.341	12.971
Norway	Europe	66.463	5887.380	58.071	70.071	3.663	14.607
Panama	America	31.821	927.245	27.902	134.621	12.278	3.754
Poland	Europe	41.442	2493.378	8.539	73.809	9.559	10.751
Portugal	Europe	66.434	2248.821	23.957	68.667	17.986	7.556
Saudi Arabia	Asia	41.848	5693.256	0.009	74.363	3.347	16.515
Singapore	Asia	70.560	5183.514	0.528	364.598	3.015	11.249
Slovak Republic	Europe	27.430	3266.546	7.853	147.022	3.742	9.089
Slovenia	Europe	47.984	3392.901	16.154	120.541	9.088	10.673
Spain	Europe	81.077	2829.885	11.352	55.951	17.052	8.527
Sweden	Europe	70.887	5445.309	42.419	82.037	4.734	7.968
Switzerland	Europe	92.447	3379.709	20.493	104.176	5.895	7.194
United Kingdom	Europe	83.550	3391.526	3.230	54.456	7.020	10.458
United States	America	85.303	7459.690	6.570	25.975	10.227	22.589
Uruguay	America	17.646	1075.759	44.690	47.598	15.829	9.789

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.eneco.2019.07.018.

References

Abdallh, A.A., Abugamos, H., 2017. A semi-parametric panel data analysis on the urbanisation-carbon emissions nexus for the MENA countries. Renew. Sust. Energ. Rev. 78, 1350–1356.

Aïssa, M.S.B., Jebli, M.B., Youssef, S.B., 2014. Output, renewable energy consumption and trade in Africa. Energy Policy 66, 11–18.

Ali, Q., Khan, M.T.I., Khan, M.N.I., 2018. Dynamics between financial development, tourism, sanitation, renewable energy, trade and total reserves in 19 Asia cooperation dialogue members. J. Clean. Prod. 179, 114–131.

Ali, Q., Yaseen, M.R., Khan, M.T.I., 2019. The causality of road traffic fatalities with its determinants in upper middle income countries: a continent-wide comparison. Transp. Res. A 119, 301–312 https://doi.org/10.1016/j.tra.2018.12.002.

Al-Mulali, U., Ozturk, I., 2015. The effect of energy consumption, urbanization, trade openness, industrial output, and the political stability on the environmental degradation in the MENA (Middle East and North African) region. Energy 84, 382–389.

Al-Mulali, U., Sab, C.N.B.C., 2012a. The impact of energy consumption and CO_2 emission on the economic and financial development in 19 selected countries. Renew. Sust. Energ. Rev. 16, 4365–4369.

Al-Mulali, U., Sab, C.N.B.C., 2012b. The impact of energy consumption and CO_2 emission on the economic growth and financial development in the Sub Saharan African countries. Energy 39, 180–186.

Al-Mulali, U., Fereidouni, H.G., Lee, J.Y., Sab, C.N.B.C., 2013a. Examining the bi directional long run relationship between renewable energy consumption and GDP growth. Renew. Sust. Energ. Rev. 22, 209–222.

Al-Mulali, U., Lee, J.Y.M., Mohammed, A.H., Sheau-Ting, L., 2013b. Examining the link between energy consumption, carbon dioxide emission, and economic growth in Latin America and the Caribbean. Renewable and Sustainable Energy Review 26, 42–48.

Al-Mulali, U., Ozturk, I., Lean, H.H., 2015a. The influence of economic growth, urbanization, trade openness, financial development, and renewable energy on pollution in Europe. Nat. Hazards 79 (1), 621–644.

Al-Mulali, U., Tang, C.F., Ozturk, I., 2015b. Does financial development reduce environmental degradation? Evidence from a panel study of 129 countries. Environ. Sci. Pollut. Res. https://doi.org/10.1007/s11356-015-4726-x.

Alvarez-Ayuso, I.C., Kao, C., Romero-Jordan, D., 2018. Long run effect of public grants and tax credits on R&D investment: a non-stationary panel data approach. Econ. Model. https://doi.org/10.1016/j.econmod.2018.06.011.

Antonakakis, N., Chatziantoniou, I., Filis, G., 2017. Energy consumption, CO_2 emissions, and economic growth: an ethical dilemma. Renew. Sust. Energ. Rev. 68, 808–824.

Apergis, N., Danuletiu, D.C., 2014. Renewable energy and economic growth: evidence from the sign of panel long-run causality. Int. J. Energy Econ. Policy 4 (4), 578–587.

Armeanu, D.S., Vintilă, G., Gherghina, S.C., 2017. Does renewable energy drive sustainable economic growth? Multivariate panel data evidence for EU-28 countries. Energies 10, 381. https://doi.org/10.3390/en10030381.

Asumadu-Sarkodie, S., Owusu, P.A., 2016. Carbon dioxide emissions, GDP, energy use, and population growth: a multivariate and causality analysis for Ghana, 1971–2013. Environ. Sci. Pollut. Res. https://doi.org/10.1007/s11356-016-6511-x.

Ayeche, M.B., Barhoumi, M., Hammas, M.A., 2016. Causal linkage between economic growth, financial development, trade openness and CO_2 emissions in European countries. American Journal of Environmental Engineering 6 (4), 110–122.

Azam, M., Khan, A.Q., 2016. Testing the environmental Kuznets curve hypothesis: a comparative empirical study for low, lower middle, upper middle and high income countries. Renew. Sust. Energ. Rev. 63, 556–567.

Banerjee, A., Cockerill, L., Russell, B., 2001. An I(2) analysis of inflation and the markup. J. Appl. Econ. 16, 221–240.

Başarir, C., Çakir, Y.N., 2015. Causal interactions between CO_2 emissions, financial development, energy and tourism. Asian Economic and Financial Review 5 (11), 1227–1238.

Bilgili, F., Koçak, E., Bulut, U., 2016. The dynamic impact of renewable energy consumption on CO_2 emissions: a revisited Environmental Kuznets Curve approach. Renew. Sust. Energ. Rev. 54, 838–845.

Boutabba, M.A., 2014. The impact of financial development, income, energy and trade on carbon emissions: evidence from the Indian economy. Econ. Model. 40, 33–41.

Brunnschweiler, C.N., 2010. Finance for renewable energy: an empirical analysis of developing and transition economies. Environ. Dev. Econ. 15 (3), 241–274.

Çetin, M., Ecevit, E., 2015. Urbanization, energy consumption and CO_2 emissions in Sub-Saharan countries: a panel cointegration and causality analysis. Journal of Economics and Development Studies 3 (2), 66–76.

Chaisumpunsakul, W., Pholphirul, P., 2018. Does international trade promote international tourism demand? Evidence from Thailand's trading partners. Kasetsart Journal of Social Sciences 39, 393–400.

Chakamera, C., Alagidede, P., 2017. The nexus between infrastructure (quantity and quality) and economic growth in Sub Saharan Africa. Int. Rev. Appl. Econ. https://doi.org/10.1080/02692171.2017.1355356.

Chang, S.C., 2015. Effects of financial developments and income on energy consumption. Int. Rev. Econ. Financ. 35, 28–44.

Charfeddine, L., Kahia, M., 2019. Impact of renewable energy consumption and financial development on CO_2 emissions and economic growth in the MENA region: a panel vector autoregressive (PVAR) analysis. Renew. Energy 139, 198–213.

Choi, I., 2006. Combination unit root tests for cross-sectionally correlated panels. In: Corbae, D., Durlauf, S.N., Hansen, B. (Eds.), Econometric Theory and Practice: Frontiers of Analysis and Applied Research: Essays in Honour of Peter C.B. Phillips. Cambridge University Press.

Chou, M.C., 2013. Does tourism development promote economic growth in transition countries? A panel data analysis. Econ. Model. 33, 226–232. https://doi.org/10.1016/j.econmod.2013.04.024.

Dogan, E., Aslan, A., 2017. Exploring the relationship among CO_2 emissions, real GDP, energy consumption and tourism in the EU and candidate countries: evidence from panel models robust to heterogeneity and cross-sectional dependence. Renew. Sust. Energ. Rev. 77, 239–245. https://doi.org/10.1016/j.rser.2017.03.111.

Dogan, E., Seker, F., 2016. The influence of real output, renewable and non-renewable energy, trade and financial development on carbon emissions in the top renewable energy countries. Renew. Sust. Energ. Rev. 60, 1074–1085.

Dogan, E., Turkekul, B., 2016. CO_2 emissions, real output, energy consumption, trade, urbanization and financial development: testing the EKC hypothesis for the USA. Environ. Sci. Pollut. Res. 23 (2), 1203–1213.

Dogan, E., Seker, F., Bulbul, S., 2015. Investigating the impacts of energy consumption, real GDP, tourism and trade on CO_2 emissions by accounting for cross-sectional dependence: a panel study of OECD countries. Curr. Issue Tour. https://doi.org/10.1080/13683500.2015.1119103.

Dumitrescu, E.I., Hurlin, C., 2012. Testing for Granger non-causality in heterogeneous panels. Econ. Model. 29, 1450–1460.

Eberhardt, M., Bond, S., 2009. Cross-section dependence in nonstationary panel models: a novel estimator. MPRA Paper 17692. University Library of Munich, Germany.

Ertugrul, H.M., Cetin, M., Seker, F., Dogan, E., 2016. The impact of trade openness on global carbon dioxide emissions: evidence from the top ten emitters among developing countries. Ecol. Indic. 67, 543–555.

Farhani, S., Chaibi, A., Rault, C., 2014. CO_2 emissions, output, energy consumption, and trade in Tunisia. Econ. Model. 38, 426–434.

Gamage, S.K.N., Kuruppuge, R.H., Haq, I.U., 2017. Energy consumption, tourism development, and environmental degradation in Sri Lanka. Energy Sources, Part B: Economics, Planning, and Policy https://doi.org/10.1080/15567249.2017.1324533.

Granger, C.W., 1969. Investigating causal relations by econometric models and crossspectral methods. Econometrica 37, 424–438.

Gungor, H., Simon, A.U., 2017. Energy consumption, finance and growth: the role of urbanization and industrialization in South Africa. Int. J. Energy Econ. Policy 7 (3), 268–276.

Hansen, B.E., 1992. Tests for parameter instability in regressions with I(1) processes. J. Bus. Econ. Stat. 10, 321–336.

Hassine, M.B., Harrathi, N., 2017. The causal links between economic growth, renewable energy, financial development and foreign trade in Gulf Cooperation Council countries. Int. J. Energy Econ. Policy 7 (2), 76–85.

Herzer, D., Donaubauer, J., 2017. The long-run effect of foreign direct investment on total factor productivity in developing countries: a panel cointegration analysis. Empir. Econ. https://doi.org/10.1007/s00181-016-1206-1.

Hossain, M.S., 2011. Panel estimation for CO_2 emissions, energy consumption, economic growth, trade openness and urbanization of newly industrialized countries. Energy Policy 39, 6991–6999.

Im, K.S., Pesaran, M.H., Shin, Y., 2003. Testing for unit roots in heterogeneous panels. J. Econ. 115, 53–74.

International Monetary Fund (IMF), 2018. International Monetary Fund. http://data.imf.org/?sk=F8032E80-B36C-43B1-AC26-493C5B1CD33B.

Işik, C., Kasımatı, E., Ongan, S., 2017. Analyzing the causalities between economic growth, financial development, international trade, tourism expenditure and/on the CO_2 emissions in Greece. Energy Sources, Part B: Economics, Planning, and Policy 12, 665–673. https://doi.org/10.1080/15567249.2016.1263251.

Islam, F., Shahbaz, M., Ahmed, A.U., Alam, M.M., 2013. Financial development and energy consumption nexus in Malaysia: a multivariate time series analysis. Econ. Model. 30, 435–441.

Jalil, A., Feridun, M., 2011. The impact of growth, energy and financial development on the environment in China: a cointegration analysis. Energy Econ. 33, 284–291.

Jebli, M.B., Youssef, S.B., Apergis, N., 2014. The dynamic linkage between CO_2 emissions, economic growth, renewable energy consumption, number of tourist arrivals and trade. MPRA Paper No. 57261, Munich Personal RePEc Archive.

Jebli, M.B., Youssef, S.B., Ozturk, I., 2015. The role of renewable energy consumption and trade: environmental Kuznets curve analysis for Sub-Saharan Africa countries. Afr. Dev. Rev. 27 (3), 288–300.

Ji, Q., Zhang, D., 2019. How much does fnancial development contribute to renewable energy growth and upgrading of energy structure in China? Energy Policy 128, 114–124.

Jiang, L., Bai, L., 2017. Revisiting the granger causality relationship between energy consumption and economic growth in China: a multi-timescale decomposition approach. Sustainability 9. https://doi.org/10.3390/su9122299.

Kao, C., Chiang, M.H., 2000. On the estimation and inference of a cointegrated regression in panel data. Adv. Econ. 15, 179–222.

Keho, Y., 2017. Revisiting the income, energy consumption and carbon emissions nexus: new evidence from quantile regression for different country groups. Int. J. Energy Econ. Policy 7 (3), 356–363.

Khan, M.T.I., Yaseen, M.R., Ali, Q., 2017. Dynamic relationship between financial development, energy consumption, trade and greenhouse gas: comparison of upper middle income countries from Asia, Europe, Africa and America. J. Clean. Prod. 161, 567–580.

Khan, M.T.I., Ali, Q., Ashfaq, M., 2018a. The nexus between greenhouse gas emission, electricity production, renewable energy and agriculture in Pakistan. Renew. Energy 118, 437–451. https://doi.org/10.1016/j.renene.2017.11.043.

Khan, M.T.I., Yaseen, M.R., Ali, Q., 2018b. The dependency analysis between energy consumption, sanitation, forest area, financial development, and greenhouse gas: a continent-wise comparison of lower middle-income countries. Environ. Sci. Pollut. Res. https://doi.org/10.1007/s11356-018-2460-x.

Lee, J.W., Brahmasrene, T., 2013. Investigating the influence of tourism on economic growth and carbon emissions: evidence from panel analysis of the European Union. Tour. Manag. 38, 69–76.

Lee, C., Chang, C., 2005. Structural breaks, energy consumption, and economic growth revisited: evidence from Taiwan. Energy Econ. 27, 857–872.

Levin, A., Lin, C.F., Chu, C.S., 2002. Unit root tests in panel data: asymptotic and finite sample properties. J. Econ. 108, 1–24.

Li, F., Dong, S., Lia, X., Liang, Q., Yang, W., 2011. Energy consumption-economic growth relationship and carbon dioxide emissions in China. Energy Policy 39, 568–574.

Maddala, G.S., Wu, S., 1999. A comparative study of unit root tests with panel data and a new simple test. Oxf. Bull. Econ. Stat. 61, 631–652.

Mark, N.C., Sul, D., 2001. Nominal exchange rates and monetary fundamentals: evidence from a small post-Bretton woods panel. J. Int. Econ. 53, 29–52.

McCoskey, S., Kao, C., 1999. Comparing panel data cointegration tests with an application of the twin deficits problem Mimeo.

Menyah, K., Nazlioglu, S., Rufael, Y.W., 2014. Financial development, trade openness and economic growth in African countries: new insights from a panel causality approach. Econ. Model. 37, 386–394.

Nasreen, S., Anwar, S., Ozturk, I., 2017. Financial stability, energy consumption and environmental quality: evidence from South Asian economies. Renew. Sust. Energ. Rev. 67, 1105–1122.

Nepal, R., Irsyad, M.I.A., Nepal, S.K., 2019. Tourist arrivals, energy consumption and pollutant emissions in a developing economy-implications for sustainable tourism. Tour. Manag. 72, 145–154.

Ohlan, R., 2017. The relationship between tourism, financial development and economic growth in India. Future Business Journal 3, 9–22. https://doi.org/10.1016/j.fbj.2017.01.003.

Pao, H.T., Tsai, C.M., 2011. Multivariate Granger causality between CO_2 emissions, energy consumption, FDI (foreign direct investment) and GDP (gross domestic product): evidence from a panel of BRIC (Brazil, Russian Federation, India, and China) countries. Energy 36, 685–693.

Paramati, S.R., Shahbaz, M., Alam, M.S., 2017. Does tourism degrade environmental quality? A comparative study of Eastern and Western European Union. Transp. Res. D 50, 1–13.

Park, Y., Meng, F., Baloch, M.A., 2018. The effect of ICT, financial development, growth, and trade openness on CO_2 emissions: an empirical analysis. Environ. Sci. Pollut. Res. 25 (30), 30708–30719.

Parks, R., 1967. Efficient estimation of a system of regression equations when disturbances are both serially and contemporaneously correlated. J. Am. Stat. Assoc. 62, 500–509.

Pedroni, P., 2001. Purchasing power parity tests in cointegrated panels. Rev. Econ. Stat. 83, 727–731.

Pedroni, P., 2004. Panel cointegration: asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. Econometric Theory 20 (3), 597–625.

Pesaran, H.M., 2004. General diagnostic tests for cross-section dependence in panels. Faculty of Economic, 1–39. https://doi.org/10.17863/CAM.5113.

Pesaran, M.H., 2007. A simple panel unit root test in the presence of cross-section dependence. J. Appl. Econ. 2 (38), 265–312.

Pesaran, M.H., Yamagata, T., 2008. Testing slope homogeneity in large panels. J. Econ. 142, 50–93.

Pradhan, R.P., Arvin, M.B., Hall, J.H., Norman, N.R., 2017. ASEAN economic growth, trade openness and banking-sector depth: the nexus. EconomiA 18, 359–379.

Rafindadi, A.A., Ozturk, I., 2016. Effects of financial development, economic growth and trade on electricity consumption: evidence from post-Fukushima Japan. Renew. Sust. Energ. Rev. 54, 1073–1084.

Rauf, A., Liu, X., Amin, W., Ozturk, I., Rehman, O.U., Hafeez, M., 2018. Testing EKC hypothesis with energy and sustainable development challenges: a fresh evidence from belt and road initiative economies. Environ. Sci. Pollut. Res. https://doi.org/10.1007/s11356-018-3052-5.

Reed, W.R., Ye, H., 2011. Which panel data estimator should I use? Appl. Econ. 43, 985–1000. https://doi.org/10.1080/00036840802600087.

Sadeghieh, M., 2016. Financial Development, CO_2 Emissions, Fossil Fuel Consumption and Economic Growth: The Case of Turkey. M.S thesis, submitted to Eastern Mediterranean University, Gazimagusa, North Cyprus.

Sadorsky, P., 2009. Renewable energy consumption, CO_2 emissions and oil prices in the G7 countries. Energy Econ. 31, 456–462.

Sadorsky, P., 2010. The impact of financial development on energy consumption in emerging economies. Energy Policy 38, 2528–2535.

Sadorsky, P., 2011. Financial development and energy consumption in Central and Eastern European frontier economies. Energy Policy 39, 999–1006.

Salahuddin, M., Alam, K., Ozturk, I., Sohag, K., 2018. The effects of electricity consumption, economic growth, financial development and foreign direct investment on CO_2 emissions in Kuwait. Renew. Sust. Energ. Rev. 81, 2002–2010.

Sarkodie, S.A., Strezov, V., 2019. Effect of foreign direct investments, economic development and energy consumption on greenhouse gas emissions in developing countries. Sci. Total Environ. 646, 862–871.

Sarkodie, S.A., Strezov, V., Weldekidan, H., Asamoah, E.F., Owusu, P.A., Doyi, I.N.Y., 2019. Environmental sustainability assessment using dynamic Autoregressive-Distributed Lag simulations-Nexus between greenhouse gas emissions, biomass energy, food and economic growth. Sci. Total Environ. 668, 318–332.

Scott, D., Peeters, P., Gössling, S., 2010. Can tourism deliver its "aspirational" greenhouse gas emissions reduction targets? J. Sustain. Tour. 18 (3), 393–408.

Sebri, M., Salha, U.B., 2014. On the causal dynamics between economic growth, renewable energy consumption, CO_2 emissions and trade openness: fresh evidence from BRICS countries. Renew. Sust. Energ. Rev. 39, 14–23.

Semancikova, J., 2016. Trade, trade openness and macroeconomic performance. Procedia Soc. Behav. Sci. 220, 407–416. https://doi.org/10.1016/j.sbspro.2016.05.515.

Shahbaz, M., Lean, H.H., 2012. Does financial development increase energy consumption? The role of industrialization and urbanization in Tunisia. Energy Policy 40, 473–479.

Shahbaz, M., Tiwari, A.K., Nasir, M., 2013a. The effects of financial development, economic growth, coal consumption and trade openness on CO_2 emissions in South Africa. Energy Policy 61, 1452-1459.

Shahbaz, M., Solarin, S.A., Mahmood, H., Arouri, M., 2013b. Does financial development reduce CO2 emissions in Malaysian economy? A time series analysis. Econ. Model. 35, 145–152.

Shahbaz, M., Hye, Q.M.A., Tiwari, A.K., Leitão, N.C., 2013c. Economic growth, energy consumption, financial development, international trade and CO_2 emissions in Indonesia. Renew. Sust. Energ. Rev. 25, 109–121.

Shahbaz, M., Sbia, R., Hamdi, H., Ozturk, I., 2014. Economic growth, electricity consumption, urbanization and environmental degradation relationship in United Arab Emirates. Ecol. Indic. 45, 622–631.

Shahbaz, M., Chaudhary, A.R., Ozturk, I., 2017. Does urbanization cause increasing energy demand in Pakistan? Empirical evidence from STIRPAT model. Energy 122, 83–93.

Shahbaz, M., Nasir, M.A., Roubaud, D., 2018. Environmental degradation in France: the effects of FDI, financial development, and energy innovations. Energy Econ. 74, 843–857.

Shahzad, S.J.H., Kumar, R.R., Zakaria, M., Hurr, M., 2017. Carbon emission, energy consumption, trade openness and financial development in Pakistan: a revisit. Renew. Sust. Energ. Rev. 70, 185–192.

Sharif, A., Afshan, S., Nisha, N., 2017. Impact of tourism on CO_2 emission: evidence from Pakistan. Asia Pacific Journal of Tourism Research 22, 408–421. https://doi.org/10.1080/10941665.2016.1273960.

Sherafatian-Jahromi, R., Othman, M.S., Law, S.H., Ismail, N.W., 2016. Tourism and CO_2 emissions nexus in Southeast Asia: new evidence from panel estimation. Environment, Development and Sustainability, DOI https://doi.org/10.1007/s10668-016-9811-x.

Sohag, K., Mamun, M.A., Uddin, G.S., Ahmed, A.M., 2017. Sectoral output, energy use, and CO_2 emission in middle-income countries. Environ. Sci. Pollut. Res. 24, 9754–9764. https://doi.org/10.1007/s11356-017-8599-z.

Stamatiou, P., Dritsakis, N., 2017. Dynamic modeling of causal relationship between energy consumption, CO_2 emissions, and economic growth in Italy. Chapter 8, Advances in Applied Economic Research. Springer, Proceedings in Business and Economics https://doi.org/10.1007/978-3-319-48454-9_8.

Suresh, K.G., Tiwari, A.K., Uddin, G.S., Ahmed, A., 2017. Tourism, trade, and economic growth in India: a frequency domain analysis of causality. ANATOLIA https://doi.org/10.1080/13032917.2017.1408025.

Swamy, P.A.V.B., 1970. Efficient inference in a random coefficient regression model. Econometrica 38, 311–323.

Tamazian, A., Rao, B.B., 2010. Do economic, financial and institutional developments matter for environmental degradation? Evidence from transitional economies. Energy Econ. 32, 137–145.

Tamazian, A., Chousa, J.P., Vadlamannati, K.C., 2009. Does higher economic and financial development lead to environmental degradation: evidence from BRIC countries. Energy Policy 37, 246–253.

Tang, C.F., Ozturk, I., 2017. Is tourism a catalyst of growth in Egypt? Evidence from Granger non-causality and the generalised variance decomposition analysis. ANATOLIA 28 (2), 173–181.

Tariq, A., Ahmad, Z., Hussain, J., 2015. The nature of relationship between international tourism and trade: a panel data perspective. Journal of Statistics 22, 9–21.

Tong, T., Yu, T.E., 2018. Transportation and economic growth in China: a heterogeneous panel cointegration and causality analysis. J. Transp. Geogr. 73, 120–130 https://doi.org/10.1016/j.jtrangeo.2018.10.016.

Tovar, C., Lockwood, M., 2008. Social impacts of tourism: an Australian regional case study. Int. J. Tour. Res. 10 (4), 365–378.

Tugcu, C.T., 2014. Tourism and economic growth nexus revisited: a panel causality analysis for the case of the Mediterranean Region. Tour. Manag. 42, 207–212. https://doi.org/10.1016/j.tourman.2013.12.007.

United Nations (UN), 2018. Sustainable Development Goals. http://un.org.

Wang, J., Dong, K., 2019. What drives environmental degradation? Evidence from 14 Sub Saharan African countries. Sci. Total Environ. 656, 165–173 https://doi.org/10.1016/j.scitotenv.2018.11.354.

Wang, T., Riti, J.S., Shu, Y., 2018. Decoupling emissions of greenhouse gas, urbanization, energy and income: analysis from the economy of China. Environ. Sci. Pollut. Res. https://doi.org/10.1007/s11356-018-2088-x.

Westerlund, J., 2007. Testing for rrror correction in panel data. Oxf. Bull. Econ. Stat. 69 (6), 709–748.

World Development Indicators (WDI), 2018. World Bank. http://databank.worldbank.org.

Xu, T., 2018. Investigating environmental Kuznets curve in China-aggregation bias and policy implications. Energy Policy 114, 315–322 https://doi.org/10.1016/j.enpol.2017.12.027.

Xu, Z., Baloch, M.A., Danish, Meng, F., Zhang, J., Mahmood, Z., 2018. Nexus between financial development and CO_2 emissions in Saudi Arabia: analyzing the role of globalization. Environ. Sci. Pollut. Res. 25(28), 28378-28390.

Yaseen, M.R., Ali, Q., Khan, M.T.I., 2018. General dependencies and causality analysis of road traffic fatalities in OECD countries. Environ. Sci. Pollut. Res. https://doi.org/10.1007/s11356-018-2146-4.

Zaidi, S.A.H., Zafar, M.W., Shahbaz, M., Hou, F., 2019. Dynamic linkages between globalization, financial development and carbon emissions: evidence from Asia Pacific Economic Cooperation countries. J. Clean. Prod. 228, 533–543.

Zaman, K., Shahbaz, M., Loganathan, N., Raza, S.A., 2016. Tourism development, energy consumption and Environmental Kuznets Curve: Trivariate analysis in the panel of developed and developing countries. Tour. Manag. 54, 275–283.

Zhang, Y.J., 2011. The impact of financial development on carbon emissions: a empirical analysis in China. Energy Policy 39, 2197–2203.

Zhu, H., Li, Z., Guo, P., 2018. The impact of income, economic openness and interest rates on housing prices in China: evidence from dynamic panel quantile regression. Appl. Econ. 50, 4086–4098. https://doi.org/10.1080/00036846.2018.1441512.

Zoundi, Z., 2017. CO_2 emissions, renewable energy and the Environmental Kuznets Curve, a panel cointegration approach. Renew. Sust. Energ. Rev. 72, 1067–1075.