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To cite this article: Ilhan Ozturk, Alper Aslan & Buket Altinoz (2022) Investigating the nexus between CO₂ emissions, economic growth, energy consumption and pilgrimage tourism in Saudi Arabia, Economic Research-Ekonomiska Istraživanja, 35:1, 3083-3098, DOI: 10.1080/1331677X.2021.1985577

To link to this article: <https://doi.org/10.1080/1331677X.2021.1985577>



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Published online: 06 Oct 2021.



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Investigating the nexus between CO₂ emissions, economic growth, energy consumption and pilgrimage tourism in Saudi Arabia

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ABSTRACT

Every year millions of Muslims go to Saudi Arabia to fulfil pilgrimage worship, thus Saudi Arabia is such a religious centre brings with it various consequences. In this context, this paper investigates the nexus between CO₂ emissions, economic growth, energy consumption and pilgrimage tourism in Saudi Arabia for the period of 1968–2017. The dynamic ordinary least squares (DOLS) and fully-modified ordinary least squares (FMOLS) methods are employed in this study. FMOLS results prove that energy consumption, number of pilgrims and oil prices have a positive effect on CO₂ emissions and GDP has a negative effect on it, while DOLS results imply that only energy consumption has a positive effect on carbon emissions. In addition, there is unidirectional causality from CO₂ to pilgrimage tourism and from pilgrimage tourism to oil, and there is bidirectional causality between pilgrimage tourism and GDP. Therefore, the environmental cost of pilgrimage tourism is inevitable. Reflections of pilgrimage visits to Saudi Arabia as a belief tourism are dealt with for the first time in this paper. In addition, our more specific purpose is to determine the environmental impacts of Muslims performing the pilgrimage, during their religious worship.

ARTICLE HISTORY

Received 23 June 2021

Accepted 21 September 2021

KEYWORDS

CO₂; pilgrimage tourism; energy consumption; Saudi Arabia

JEL CODES

Q43; Q55; Z3

1. Introduction

Tourism can be defined as a trip outside of the place of residence, not exceeding one year, for leisure, business, and other similar purposes. In the last century, the most significant contribution to the development in terms of both economic and social phenomena has been realised through the tourism sector. Many factors are influential in the development of tourism and also religious motivation is one of the most

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important factors. This phenomenon, now called belief tourism, is directed towards visiting sacred places and fulfilling religious obligations. The cities considered as centres for religion have critical importance for belief tourism. Among them, the Vatican for Christians, Varanasi for Hindus, Lhasa for Buddhists, and Mecca for Muslims are regarded as religious centres. The visit of tourists belonging to the religions to the sacred places is expressed as belief/pilgrimage tourism. In the last decades, belief tourism has improved considerably due to the fact that travel to the entire world is cheaper and easier (Hassan, 2015). The definition of belief tourism was made by the World Tourism Organization in 1985 and this definition focussed on religious events, festivals, sacred places, and pilgrimage (See also Collins-Kreiner, 2020).

Since pilgrimage is a religious obligation for Muslims, Saudi Arabia where Mecca and Medina cities are located is an important centre of belief tourism. Pilgrimage is generally defined as a physical visit to a place made to pray, to practice various rituals according to faith and to spiritually purify and/or enlighten (Gunlu & Okumus, 2010). Saudi Arabia economy, before oil was found; was based on trade, agriculture, and income from expenditures of the pilgrims coming to the cities of Mecca and Medina during the Hajj seasons. Today, although petroleum has an important place in the economy of the country, pilgrim revenues are still an important source of income. It is inevitable that Saudi Arabia was influenced by these activities because the pilgrimage lasts for about the three weeks and pilgrims continue their vital activities in the cities. Therefore, the environmental cost of pilgrimage tourism is inevitable. Reflections of pilgrimage visits to Saudi Arabia as a belief tourism are dealt with for the first time in the literature in this paper. In addition, our more specific purpose is to determine the environmental impacts of Muslims performing the pilgrimage, during their religious worship. Thus, this study explores the relationship between pilgrimage tourism, environmental pollution, energy use and economic growth for Saudi Arabia data period from 1968 to 2017. The period studied gained importance due to the incredible increase in the number of pilgrims. The number of pilgrims, which was about 320 thousand in 1968, increased almost 7 times to reach 2.5 million people by the year 2019.

Empirical studies in the literature mainly focus on the economic growth effects of tourism in general terms (Aslan, 2014, 2016; Bilen et al., 2017; Brida et al., 2015; Gricar et al., 2021; Habibi et al., 2018; Haller et al., 2021; Kim et al., 2006; Seetanah, 2011). In addition to these, tourism, energy and carbon emissions link has also been the subject of various studies (Adedoyin et al., 2021; Ahmad et al., 2018; Azam et al., 2018; Chishti et al., 2020; Işık et al., 2017; Jebli et al., 2014; Pablo-Romero et al., 2019; Sharif et al., 2017, 2020a, 2020b; Tang & Abosedra, 2014; Tiwari et al., 2013; Xiangyu et al., 2021). However, the current empirical literature, based on the effects of pilgrimage activities for Saudi Arabia, is lacking. The contribution to the economic activities of Saudi Arabia and especially the influence of the visitors coming to Mecca and Medina on the development and modernisation of these cities should not be ignored in relation to the issues of energy and carbon emission (Foruzan, 2014; Pinter, 2014).

In this context, a number of purposes are adopted in the study. Firstly, this study aims to take into account belief tourism, which is not defined as a leisure activity

(Srivastava, 2019) and its effects. Thus, the lack of literature is tried to be completed and empirical evidence on the effects of belief tourism is presented and theoretical explanations are emphasised. Secondly, our more specific purpose is to determine the environmental impacts of Muslims performing the pilgrimage, during their religious worship. Hence, the main hypothesis is that pilgrimage tourism affects Saudi Arabia's air pollution. Also, it contributed to the discussed CO₂-tourism-energy-GDP nexus from a religious perspective. Finally, it presents a number of policy recommendations. The study uses dynamic ordinary least squares (DOLS) and fully-modified ordinary least squares (FMOLS) method, which are used with reliable long run results in the direction of the advantages of these methods. The DOLS method is an effective estimator for eliminating deviations from the inherent problem between arguments and error term, and FMOLS method is an effective estimator for eliminating deviations from the problem of internality and successive correlations between independent variables and error term. These advantages of the methods lead to their adoption in the study. In addition, causality relationship between variables is demonstrated with Granger causality test.

In conclusion, the contributions of this study can be summarised as follows: First, tourism is proved to be an economic and environmental reflection of not only leisure activity but also for a psycho-social purpose. In this context, reflections of pilgrimage visits to Saudi Arabia as a belief tourism are dealt with for the first time in this paper. Second, in order to draw attention to these links, the relationship between belief tourism, GDP growth, energy consumption and carbon emissions is modelled econometrically and concrete evidence are presented by estimating the coefficient with the DOLS and FMOLS methods and by determining causality relationship between variables with the Granger causality test. Finally, a conclusion is made about the benefits or costs of pilgrimage tourism incurred to Saudi Arabia. In other words, it is investigated whether the presence of Mecca, which is considered a religious centre for Muslims, in the territory of Arabia is an advantage or disadvantage for Saudi Arabia. Thus, the aim of this paper is to investigate the nexus between CO₂ emissions, economic growth, energy consumption and pilgrimage tourism in Saudi Arabia for the period of 1968–2017.

2. Theoretical framework and empirical literature survey

2.1. Pilgrimage and tourism theory

Pilgrimage, is one of the most important worships of Buddhism, Hinduism, Islam, Judaism and Christianity, the leading religions of the world. This worship is naturally associated with tourism in the sense that it is based on spatial mobility (Collins-Kreiner, 2010). The increase in the studies on pilgrimage tourism in time is related to the pilgrimage places as the attraction point for many people, and so, this subject has become a phenomenon in academic literature. Researchers interested in the concept of belief tourism have also intensively analysed the links between pilgrims and tourists (Olsen, 2010). Therefore, the similarity between tourism and pilgrimage is the reason for intense theoretical studies on the subject of pilgrimage tourism.

Pioneering studies related to pilgrimage and tourism belongs to Turner (1973) and Turner and Turner (1978). These studies, which have gained value in the field of tourism sociology, started the “Turnerian tradition” in many studies. Turner and Turner (1978) express the transition from a person’s everyday life to a sacred centre as a pilgrimage. Turner’s reference to tourism based on pilgrimage worship has been motivation for many studies (Cohen, 1979, 1992; MacCannell, 1973; Smith, 1989, 1992; etc.) that follow him. The studies focussed on the complex relationship between pilgrimage and tourism (Eade, 1992). Also the studies have tried to define the concept of pilgrimage in various ways. Some of these have described pilgrimage as a social obligation, a rite of passage, way to obtain religious right, and desire to find a spiritual healing and a search for meaning (Brown & Osman, 2017). Thus it can be said that travel and religious activities constitute one another. Based on all these explanations, it can admit that the fact that some places are more sacred than others is the core of the human-religion-travel relation (Norman & Cusack, 2014).

Although pilgrimage in general is spiritually compelling according to different beliefs, there are also belief travels that are not compulsive. For example, while pilgrimage is a religious obligation for Muslims, umrah means only visiting. Therefore, since pilgrimage tourism is a more limited concept, explanations are made within the framework of the concept of belief tourism, which includes pilgrimage tourism in general. One of the more recent studies on belief tourism, Blackwell (2007) listed religious target, religious symbol/places and religious motivation as elements of belief tourism. A comprehensive description of the elements of belief tourism is made by Shackley (2001). These are: Natural places (lakes, mountains, etc.), buildings constructed for religious activities, buildings with religious figure, special events related to religious happenings in anywhere, religious monuments. Motivation is the factor that attracts people to all these listed events and/or places. Chaspoul (1993) discussed the concept of motivation in detail in the context of belief tourism. Chaspoul explain this concept from spiritual, sociological, cultural and geographic perspectives. These are respectively to get closer to God, to get to know the religion better, to recognise religious symbols and cultural events, to determine the changes in behaviour (Negrusa et al., 2015).

In addition to the relationship between pilgrimage, which included in belief tourism, and tourism, similarities and differences between pilgrims and tourists have been mentioned in many studies. MacCannell (1973) suggest that pilgrims’ desire to be in a religious space is similar to the desire of tourists to go to a social, historical or cultural place (Belhassen et al., 2008). The studies in the literature approach tourist and pilgrim from two different perspectives. First, although tourists and pilgrims are different from each other, they constitute a continuity of complementary elements. Travel and spatial motion are complementary elements, the motive that constitutes the purpose of this movement represent the difference between them. The second perspective is that pilgrims are not tourists. This perspective focuses only on the purpose and/or impulse element, unlike the first opinion (Timothy & Olsen, 2006). Another approach to pilgrim and tourist concepts is developed by Smith (1989). This study focussed on the travel process in determining the similarity or difference between the two concepts. While the pilgrimage includes a spiritual destination,

tourism includes a worldly process. Another study that gives a different dimension to the connection between tourism and pilgrimage belongs to Cohen (1992). He classified pilgrims and tourists, as tourist who is pilgrim and traveller. While pilgrim carries a sociocultural meaning, tourist is a more general concept.

In the context of pilgrimage and tourism, it is understood that the belief tourism, attracts great attention in the historical process. On the other hand, even though the pilgrimage worship has an earlier history than tourism, it has started to be addressed with the emergence of tourism. Therefore, the pilgrimage ensures a theoretical basis for tourism, while at the same time improving in connection with the development of tourism.

2.2. Empirical literature survey

Studies in the literature have dealt with tourism-gdp-energy-CO₂ relations without distinction between belief tourism and other tourism activities. For this reason, the results of the selected empirical studies, which have investigated the general tourism and its effects, are presented in this section.

There are many empirical studies that have investigated the nexus between tourism development and economic growth. Oh (2005) illustrated that there is no causality from tourism to economic growth in Korea for the period from 1975 to 2001, using Engle and Granger to stage causality approach and VAR method. A similar result obtained by Ozturk and Acaravci (2009) by applying ARDL method that using 1987–2007 data from Turkey. When the studies in which the causality analysis is applied are examined, the results are divided into three groups. Firstly, studies that obtained the results that there is bidirectional causality between economic growth and tourism are included in the literature. For example, Kim et al. (2006) for Taiwan, Assadzadeh and Nasab (2012) for Iran, Massidda and Mattana (2013) for Italy, Aslan (2016) for Turkey, Bilen et al. (2017) for Mediterranean countries found bidirectional causality. In addition to these, Brida et al. (2008) conducted a cointegration and causality analysis for Mexico using data from the 1980–2007 periods and found a unidirectional causality from tourism development and economic growth. Lee and Chang (2008) found similar results in the analysis of OECD countries and nonOECD countries for the period 1990–2002, but the effect is larger in nonOECD countries. Other studies Akinboade and Braimoh (2010), Narayan et al. (2010), Schubert et al. (2011), Seetanah (2011), Brida et al. (2015), Tang and Tan (2015), which find a unidirectional causality relationship from tourism development to economic growth.

On the other hand, Aslan (2014) achieved different results as a result of panel causality test with Mediterranean countries' 1995–2010 period data. The test results proved that there is a unidirectional causality from economic growth to tourism development in Spain, Italy, Tunisia, Cyprus, Croatia, Bulgaria and Greece, while proving the bidirectional causality for Portugal. Habibi et al. (2018) examined the contribution of tourism to economic growth in Iran for the period from 2005 to 2014. Their results suggested that tourism has a positive impact on growth. Santamari and Filis (2019) studied for Spain, using DCC_GARCH method, and empirical findings demonstrated that the contribution of tourism to growth varies over time.

More recent studies deal with the interaction between the tourism sector and energy use, growth and environmental pollution. Liu et al. (2011) investigated the relationship between tourism industry, carbon emission and energy requirements in Western China for the period from 1999 to 2004, using decomposition analysis. Their results illustrated that energy intensity, expenditure size and the industry size has an enhancing effect on carbon emission growth. Also, energy intensity has a negative effect on the increase of carbon emission levels while the expenditure size and the tourism industry size have a positive effect on it. Tiwari et al. (2013) dealt with the nexus between tourism, energy consumption and climate change in 25 OECD countries during 1995–2005, using panel VAR method. Analysis results showed that response of tourism in one standard deviation shock in climate change and energy use and response of climate change emissions to tourism is positive. Tang and Abosedra (2014) included political instability in relation to tourism-economic growth-energy use. Their paper analysed the data of 24 MENA countries for data period from 2001 to 2009, using GMM estimator and their results imply that energy consumption and tourism contribute to the economic growth of MENA countries. Jebli et al. (2014) researched that relationship between CO₂ emissions, economic growth, renewable energy consumption, tourist arrivals and trade. They used Central and South America's 1995–2010 data period and they applied panel cointegration and Granger causality test. Their empirical analysis results reached that both tourist arrivals and renewable energy consumption contribute to the reduction of emissions, while both real GDP and trade contribute to the emissions growth in the long run. Also, long run results prove that there is evidence of bidirectional causality between emission, renewable energy use and tourist arrivals. Katircioglu et al. (2014) investigated relationship among international tourism, energy consumption and CO₂ for Cyprus. They revealed that tourist arrivals have a positive and statistically significant impact on the level of energy consumption and CO₂ emissions. According to Danish et al. (2019), energy consumption is responsible for the increase in CO₂ emissions in all income groups. Liu et al. (2019) studied for Pakistan covered the data period from 1980 to 2016. Their results suggested that there is no significant relationship between tourism and pollution. Eyuboglu and Uzar (2020) revealed that tourism, energy use and growth impede environmental quality by increasing the concentrations of emissions in Turkey. Kumail et al. (2020) investigated the nexus between tourism and pollution in Pakistan by using ARDL boundary analysis. Findings illustrated that tourism and economic growth damage to air quality.

Zaman et al. (2016) investigates the relationship between tourism development, energy consumption and environmental Kuznets curve in 34 developed and developing countries for data period from 2005 to 2013. They came to the conclusion that there is an inverted U-shaped relationship between carbon emissions and per capita income. Dogan and Aslan (2017) explored that relationship between CO₂ emissions, real GDP, energy consumption and tourism in European Union countries for 1995–2011 data period, using FMOLS and DOLS methods and panel Granger causality test. Their results implied that there is unidirectional causality running from tourism to carbon emission and bidirectional causality between CO₂ emission and energy consumption, and between real GDP and CO₂ emission. Işık et al. (2017) researched

that the nexus between tourism, energy and growth for the Top 10 most-visited countries, using Granger causality test and they reveal that growth led energy in China and there is bidirectional causality between growth and energy in Italy and USA. Also, tourism leads growth in China and Turkey. Azam et al. (2018) tested the effect of tourism on environmental quality in Malaysia, Singapore and Thailand. Their results illustrated that while the effect of tourism is positive in Malaysia, there is an inverse relationship in Thailand and Singapore. Pablo-Romero et al. (2019) investigated the tourism and environmentally effects in 12 Spanish Mediterranean provinces for the 1999–2014 data period. Empirical results suggested that tourism developments lead to electricity consumption, and thus temperature variables. Koçak et al. (2020) reinvestigated the nexus between tourism and CO₂ emissions, and they revealed that causal relationship between tourism developments and air pollution in the long run.

When the empirical literature investigating the relation between tourism, energy, carbon emissions and growth is examined, it is seen that there is no distinction about belief tourism and there is a lack of literature in this respect. Ultimately this lack of literature is tried to be completed with this paper, which considers the various influences of the number of pilgrims in Saudi Arabia, attempts to address this lack of literature.

3. Data, model specification, and methodology

3.1. Data

In this paper, which investigates the relation of belief tourism with GDP, carbon emission and energy consumption, we use Saudi Arabia's 1968–2017 period data. Table 1 presents the variables used in this paper. As an indicator of belief tourism, the number of pilgrims coming from abroad to Saudi Arabia is used and obtained from Al-Medina Education Center website, annexes. CO₂ emissions, GDP and energy are provided from the World Bank database. Crude oil price included in the analysis as a control variable is obtained from the Statista website. All variables are logarithmically included in the basic analysis model.

3.2. Model specification

Since the relationship between number of pilgrims, energy use, carbon emissions and economic growth are examined for the first time in this paper, we considered also following studies (Dogan & Aslan, 2017; Katircioglu et al., 2014; etc.) in the model specification. As similar to that of Dogan and Aslan (2017), this paper uses the following function:

Table 1. Data and sources.

Variable	Describe	Source
Number of pilgrims	Person	Al-Medina Education Center (annexes)
Energy consumption	kg of oil equivalent per capita	WDI
Economic growth	GDP growth (annual %)	WDI
Carbon emissions (CO ₂)	kt	WDI
OPEC crude oil price	in U.S. dollars per barrel	The Statistics Portal (Statista)

Source: World Development Indicators (<https://databank.worldbank.org/>), The Statistics Portal (Statista) (www.statista.com), Al-Medina Education Center (annexes) (<http://www.mec1.org/umra/en/>).

$$CO_2 = f(GDP, EN, HAJJ, OIL) \quad (1)$$

The response variable is CO₂, while the explanatory variables are GDP, energy use (EN), number of pilgrims (HAJJ) and OPEC crude oil prices (OIL) respectively. In the framework of the model adopted, the main hypothesis is that pilgrimage will negatively affect Saudi Arabia's air pollution. The econometric model constructed according to Equation (1) and based on time series data is as follows:

$$\log_e CO_2_t = \beta_0 + \beta_1 \log_{gdp} t + \beta_2 \log_e n_t + \beta_3 \log_{hajj} t + \beta_4 \log_{oil} t + \mu_t \quad (2)$$

where t denotes time series (1968–2017). Each β represents the slope coefficient of the corresponding variable and finally μ_t indicates the estimation residual. All variables are logarithmically analysed.

3.3. Methodology

3.3.1. Unit root test

The first step of time series analysis is to investigate whether the series are stationary. The stability of the series is tested by the ADF unit root test. For the ADF unit root test, the null hypothesis shows that the series are not stationary and the alternative hypothesis is that the series are stationary.

3.3.2. Cointegration test

After the stationary of the series is tested with the ADF unit root test, the long run cointegration between the variables is tested using the Johansen cointegration test developed by Johansen (1988), Johansen and Juselius (2009). The Johansen cointegration method, which is vector autoregressive based, is considered strong in detecting multiple cointegration relationships between these series when there are multiple explanatory variables. The advantage of the Johansen method is that the level values of the series are used in long run analysis, so that the series contains as much information as possible.

3.3.3. Long run coefficient estimators

The coefficients are estimated at the next stage under the condition that the cointegration relation is determined. For this purpose, DOLS method developed by Stock and Watson (1993) and FMOLS method developed by Phillips and Hansen (1990), Hansen (2002) are used. The FMOLS method developed the OLS method to explain the endogeneity in the explanatory variables resulting from the presence of the serial correlation effects and the cointegration relationship and this method is formulated as below (Mehmood & Shadid, 2014):

$$\hat{\Theta} = \begin{bmatrix} \hat{\beta} \\ \hat{\gamma}_1 \end{bmatrix} = \left(\sum_{n=1}^N Z_n Z_n' \right)^{-1} \left(\sum_{n=1}^N Z_n y_n^* - N \begin{bmatrix} \hat{\lambda}_{12}^* \\ 0 \end{bmatrix} \right) \quad (3)$$

DOLS method is an improved approach to the creation of an effective estimator applied to the cointegrated series that eliminates feedback, and the basic equality of the method is as follow (Mehmood & Shadid, 2014):

$$y_t = X_t' + D_{1t}' \Upsilon_1 + \sum_{k=-z}^l \Delta X_{t+k}' \sigma + \mu_{1t} \quad (4)$$

Under the assumption that adding z lags and r leads of the differenced regressors soaks up all of the long run correlation between μ_{1t} and μ_{2t} , least squares estimates of Θ have the same asymptotic distribution as those obtained from FMOLS.

The DOLS method is an affective estimator for eliminating deviations from the inherent problem between arguments and error term, and FMOLS method is an effective estimator for eliminating deviations from the problem of internality and successive correlations between independent variables and error term. These advantages of the methods lead to their adoption in the study.

3.3.4. Causality test

Finally, the causality relationship between variables is determined by Granger causality analysis. The Granger causality test is used to establish the existence of the relationship between variables and to determine the direction of this relationship, if any. The equations for this test are shown as below (Engle & Granger, 1987; Granger, 1988):

$$y_t = \sum_{i=1}^z \alpha_i y_{t-i} + \sum_{i=1}^z \beta_i x_{t-i} + \mu_{1t} \quad (5)$$

$$x_t = \sum_{i=1}^z \Theta_i x_{t-i} + \sum_{i=1}^z \Upsilon_i y_{t-i} + \mu_{2t} \quad (6)$$

where α_i , β_i , Θ_i and Υ_i denotes lag coefficient, z implies common lag degree for all variables, and μ_{1t} and μ_{2t} show error terms.

4. Empirical results

4.1. Unit root test result

Stationary analysis is performed for the eight-time series. The ADF unit root test is used and the results are shown in Table 2. According to the results, all the series contain unit roots at the level and become stationary when the first differences are taken.

4.2. Cointegration test results

Unit root test results show that the precondition (all variables are stationary at the first difference) for cointegration and coefficient estimation methods used in the paper is provided. The results of cointegration are presented in Table 3.

The cointegration investigation is tested using the Johansen approach. The null hypotheses are $r=0$ (no cointegration), $r \leq 1$ (there is at most one cointegration relation), $r \leq 2$ (there are at most two cointegration relations), $r \leq 3$ (there are at most

Table 2. ADF unit root test results.

Variable	None	Trend and intercept	Intercept
log_co2	-0.885(0.327)	-0.782(0.960)	-0.631(0.853)
log_en	-0.725(0.397)	-1.822(0.678)	-2.314(0.171)
log_gdp	1.902(0.985)	-3.130(0.111)	-2.971(0.044)**
log_hajj	2.090(0.990)	-3.679(0.033)	-1.846(0.354)
log_oil	0.654(0.854)	-2.068(0.550)	-2.360(0.158)
First difference			
log_co2	-6.902(0.000)*	-7.293(0.000)*	-6.918(0.000)*
log_en	-6.960(0.000)*	-7.723(0.000)*	-6.886(0.000)*
log_gdp	-3.993(0.000)*	-4.963(0.001)*	-4.612(0.000)*
log_hajj	-7.898(0.000)*	-8.587(0.000)*	-8.652(0.000)*
log_oil	-6.069(0.000)*	-6.512(0.000)*	-6.296(0.000)*

*and ** denotes respectively %1 and %5 statistically significance level.

Source: Authors' Calculations.

Table 3. Johansen cointegration test results, dependent variable: log_co2.

Null hypothesis	Trace statistic	0.05 critical value	Probability
$r = 0$	87.160	79.341	0.011*
$r \leq 1$	56.615	55.245	0.037*
$r \leq 2$	30.653	35.010	0.135
$r \leq 3$	9.245	18.397	0.555
$r \leq 4$	0.288	3.841	0.591

Note. AIC, SC and HQ results are based on determining the optimal lag length (lag 1).

*Denotes statistically significance for %5 critical value.

Source: Authors' Calculations.

Table 4. DOLS and FMOLS test results, dependent variable: log_co2.

Regressors	DOLS		FMOLS	
	Coefficient	P-value	Coefficient	P-value
log_en	0.712	0.000*	0.892	0.000*
log_gdp	-0.701	0.415	-3.125	0.004*
log_hajj	1.551	0.209	3.256	0.046**
log_oil	0.267	0.656	1.696	0.079***

*, ** and *** denotes respectively %1, %5 and %10 statistically significant level.

Source: Authors' Calculations.

three cointegration relations) and $r \leq 4$ (there are at most four cointegration relations), the trace statistics show that probability values are statistically significant for $r = 0$ and $r \leq 1$, i.e., null hypotheses are rejected. Thus, the results indicate that the existence of cointegration.

4.3. Long run estimation result

DOLS and FMOLS methods are applied to estimate the long run coefficient after the existence of the long run cointegration among variables. Firstly, it can be said that when the results of the DOLS are examined, energy consumption has a statistically significant coefficient (Table 4). This result means that in the long run the energy consumption has an effect of increasing the carbon emissions. On the other hand, FMOLS results show that the coefficients for all variables are statistically significant. Also, the GDP coefficient has a negative value and the coefficients of the other variables are positive. In other words, an increase in energy consumption, number of

pilgrims and oil prices increase carbon emissions, while an increase in GDP reduces this emission.

The results are similar to Liu et al. (2011), but are inconsistent with the findings of Jebli et al. (2014). In addition, the increasing effect of the tourist arrivals on CO₂ emissions reached by Katircioglu et al. (2014) is in line with the effect of the number of pilgrims. At the same time, while the conclusions of the energy consumption and GDP are similar to those of Dogan and Aslan (2017), the findings regarding the impact of the number of pilgrims are inconsistent with their tourism results.

The results achieved in terms of pilgrimage tourism are remarkable for Saudi Arabia. Accordingly, the fact that the coefficients are positive highlights the importance of the share of pilgrimage activity in air pollution, although it covers a certain period of the country. Therefore, hosting a large number of pilgrims during a certain period of the year harms the environmental quality of the country. When considered together with the contributions of pilgrimage tourism to the country's economy, it became clear with the findings that it actually causes a significant environmental cost in the long run. On the other hand, during the pilgrimage period, an increase in energy consumption is expected due to periodic population growth. This is a factor explaining the increase in emissions resulting from energy consumption. A similar effect exists for oil and GDP.

4.4. Causality test result

After estimating the coefficients, the causality relationship between the variables are investigated in the last stage of the analysis, using Granger causality method, and the results are presented in Table 5.

The probability values in Table 5 indicate the existence of four causality relations. Firstly, there is unidirectional causality from carbon emissions to the number of

Table 5. Granger causality test results.

Null hypothesis	F-statistic	P-value
log_en \neq > log_co2	0.066	0.797
log_co2 \neq > log_en	1.210	0.277
log_gdp \neq > log_co2	2.194	0.145
log_co2 \neq > log_gdp	0.058	0.810
log_hajj \neq > log_co2	0.696	0.408
log_co2 \neq > log_hajj	4.484	0.039**
log_oil \neq > log_co2	1.965	0.167
log_co2 \neq > log_oil	0.690	0.410
log_gdp \neq > log_en	2.122	0.152
log_en \neq > log_gdp	0.931	0.339
log_hajj \neq > log_en	0.420	0.519
log_en \neq > log_hajj	1.094	0.301
log_oil \neq > log_en	2.032	0.160
log_en \neq > log_oil	2.725	0.105
log_hajj \neq > log_gdp	10.482	0.002*
log_gdp \neq > log_hajj	3.743	0.059***
log_oil \neq > log_gdp	1.495	0.227
log_gdp \neq > log_oil	2.614	0.112
log_oil \neq > log_hajj	0.286	0.595
log_hajj \neq > log_oil	8.363	0.005*

*, ** and *** denotes respectively %1, %5 and %10 statistically significant level.

Source: Authors' Calculations.

pilgrims. This result, which expresses the causality relation between carbon emissions and the number pilgrims, is compatible with Tiwari et al. (2013), but not with Dogan and Aslan (2017). Another result of causality proves that there is a bidirectional causality relationship between number of pilgrim and GDP. This result is incompatible with Oh (2005), and Ozturk and Acaravci (2009), while it is consistent with Kim et al. (2006); Assadzadeh and Nasab (2012); Massidda and Mattana (2013); Aslan (2016) and Bilen et al. (2017), as compared to studies focussing on the relationship between tourism and growth nexus and predominantly based on causality analysis. Finally, it is found that there is unidirectional causality from number of pilgrims to oil prices.

5. Conclusion and policy implications

Belief tourism is an interdisciplinary subject which has been studied from past to present. Studies have shown that faith tourism is examined in many areas such as sociology, anthropology, psychology, and economics. On the other hand, the literature indicates that the studies in the fields of economics generally focus on tourism and that they have relatively less interest in belief tourism. However, pilgrimage tourism is similar in many ways with other tourism activities, and a pilgrim almost completely has characteristics of a tourist. Thus, the crowding in the largest cities of Saudi Arabia during the pilgrimage period has both socioeconomic and economic effects. In particular, its impact on environmental pollution, which cannot be compensated, is should be consider important due to the acceleration of climate change studies.

The point of departure of this paper is that the possible effects of belief tourism and especially pilgrimage activity have been neglected in the literature. In this context, since Saudi Arabia is visited by thousands of pilgrims from different countries each year, it is inevitable that the activity has various effects on this country. The analysis results showed that the existence of a cointegration among all variables, and in the long run number of pilgrims increase carbon emissions in Saudi Arabia for data period 1968–2017. The results of causality proved the existence of bidirectional causality between the both variables. These findings, which are similar to the general literature on tourism, emphasise the importance of investigating the effects of pilgrimage tourism.

Air pollution, which one of the most important factor in sustainable growth, increases as a result of the pilgrimage activity. Therefore, this problem raises various policies to prevent the country's pilgrimage tourism from causing environmental degradation. Also, compared to the causality test results, although there is a causal relationship between pilgrimage tourism and GDP, the contribution of this activity to economic growth is not sustainable. Because even if the pilgrimage tourism causes an economic growth, this effect disappears with the long run pollution effect. Hence, if policy makers want to obtain the economic contributions of pilgrimage tourism, a number of environmental rules need to be implemented. Identifying environmental trends in the behaviours of visitors may be a first step, and then several restrictions may be required. Another alternative is to set a quota for the number of visitor. Because the environmental cost of all kinds of activities is of considerable importance nowadays. However, the fact that Arabia is a pilgrimage centre caused an intensive visit of pilgrims to the country in the period specified as belief. In other words, it

may be suggested to increase the share of renewable energy sources in the overall energy composition of the country rather than measures for this activity. Thus, environmental damage of pilgrimage tourism may be reduced by ensuring that services such as accommodation and transportation for pilgrims are environmentally friendly.

This paper, based on the pilgrimage statistics of Saudi Arabia, encourages studies on other belief activities that are to be carried out after this. It may also be useful to make a comparison in terms of the results of future analysis of pilgrims grouped by origin country. This paper and future papers will lead to inferences for the cities or countries that are a belief centre. Indeed, the fact that there is bidirectional causality with GDP, one of the most important macroeconomic indicators, clearly demonstrates the contribution of the pilgrimage activity to the Arabian economy.

Disclosure statement

No potential conflict of interest was reported by the authors.

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