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Comparative Empirical Study for Islamic and Non-Islamic Emerging Economies

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Abstract
The purpose of this study is to empirically investigate the relationships between CO2 emissions, energy consumption, economic growth, trade openness, and urbanization within the framework of the Environmental Kuznets Curve (EKC) hypothesis for 11 Islamic and 11 non-Islamic Emerging Economies in the period of 1990-2018. For this purpose, the long-term relationship between variables is investigated for both country groups using MG, AMG, and CCEMG estimators. The results show that the effect of energy consumption on CO2 is significantly positive in both country-specific and panel results. In non-Islamic emerging economies, there is a significantly positive relationship between urbanization and CO2 for most country-specific and panel results, whereas the effect of urbanization on CO2 is significantly negative for most country-specific and panel results in Islamic emerging economies. The effect of trade openness on CO2 is significantly negative in most Islamic and non-Islamic emerging economies. In panel results, the effect of trade openness on CO2 is significantly negative in non-Islamic emerging economies while it is insignificantly negative in Islamic emerging economies. The country-specific results within the framework of the EKC hypothesis show that the EKC hypothesis is valid for Malaysia and Kuwait in Islamic emerging economies as well as Argentina, China, and Thailand in non-Islamic emerging economies for all models. The panel results represent that the EKC hypothesis is

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not valid for Islamic emerging economies in all models while valid for non-Islamic emerging economies in MG and AMG models.

Keywords
Islamic Countries, Ekc Hypothesis, Emerging Markets, Trade Openness, Urbanization

Çevresel Kuznets Eğrisi Hipotezinin İslami ve İslami Olmayan Gelişmekte Olan Ekonomiler İçin Karşılaştırmalı Olarak Analizi

Öz
Bu çalışmanın amacı, 11 İslami ve 11 İslami Olmayan gelişmekte olan ülkeler için Çevresel Kuznets Eğrisi (EKC) hipotezini dikkate alarak karbon emisyonları, enerji tüketimi, ekonomik büyüme, ticarete açıklık ve kentleşme arasındaki ilişkiyi karşılaştırmalı olarak incelemektir. Bu amaçla, MG, AMG ve CCEMG yöntemleri kullanılarak her iki ülke grubu için değişkenler arasındaki uzun dönemli ilişki araştırılmıştır. Sonuçlar, enerji tüketiminin CO2 üzerindeki etkisinin hem ülkeye özel hem de panel sonuçlarında anlamlı ve pozitif olduğunu göstermektedir. İslami olmayan gelişmekte olan ülkelerde, panel sonuçları için kentleşme ile CO2 arasında anlamlı ve pozitif bir ilişki varken, İslami gelişmekte olan ülkelerin çoğunda ülkeye özgü ve panel sonuçları için kentleşmenin CO2 üzerindeki etkisi anlamlı ve negatiftir. Ticari açıklığın CO2 üzerindeki etkisi, İslami ve İslami olmayan gelişmekte olan ülkelerin çoğunda anlamlı ve negatiftir.

Anahtar Kelimeler
İslam Ülkeleri, Ekc Hipotezi, Gelişmekte Olan Ülkeler, Ticari Açıklık, Kentleşme

Introduction

The global greenhouse gases (GHG), including carbon emissions trend, have increased since the beginning of the last century compared to the three previous decades due to the increase in carbon emissions from China and other emerging countries. In the year 2018, the world's biggest CO2 emitters are China, the United States, India, Russia, Japan, and European Union countries. These countries are composed of 51% of the earth population and 65% of global GDP, whereas energy consumption of these countries accounts for about 80% of total global energy consumption and 67.5% of total global CO2 emission (Olivier & Peters, 2018; S. Wang et al., 2016). Therefore, atmospheric residues of GHG have increased significantly and caused a natural greenhouse effect, which adversely affects life in the world. Despite the treaties on reducing greenhouse gas levels, carbon emissions are still the primary cause of global warming and increasing worldwide day by day. It is thought that environmental pollution in a country is not only dependent on income but also on factors such as energy consumption, population growth, urbanization, and trade openness (Crippa et al., 2019; Yasin et al., 2020b; Yasmeen et al., 2020; Zameer et al., 2020).

As a result of the rapid increase in GHG, including CO2, the world faces many problems such as climate change and global warming. The Kyoto Protocol, signed in 1997 by 160 countries in Japan, is a milestone to reduce GHG. Each country has a responsibility to reduce current carbon emissions to an acceptable level. Each country groups' ability and priority to deal with climate change not only depend on their economic development level but also social factors such as religion. Although Islamic and non-Islamic Emerging Markets signed the Kyoto protocol to curb emission levels, there is still a long way to go.

After the signing of the Paris Agreement in 2015, most countries have reached an agreement on developing a low-carbon economy. For example, The Chinese government aims to reduce carbon intensity by 60–65% until 2030, according to its 13th Five-year Plan (Shahbaz et al., 2020).

The relation between CO2, energy consumption, and economic growth has received attention and the achievement of sustainable GDP growth has gradually become a major global concern over the recent years. However, policymakers and scientists' concern regarding environmental pollution has also increased at the same time. In this context, the effects of GDP and energy

consumption on environmental pollution have been investigated with the Environmental Kuznets Curve (EKC) hypothesis (Aydin & Turan, 2020; Destek et al., 2018; Dogan & Inglesi-Lotz, 2020; Gormus & Aydin, 2020; Pata & Aydin, 2020; Yasin et al., 2020b). According to this hypothesis, environmental pollution increases to a point as income increases, then environmental pollution decreases. Hence, the relationship between environmental pollution and GDP is revealed (Grossman & Krueger, 1995).

The relevant literature has shown that our study is unique in terms of the sample. There are a lot of studies about EKC in the literature which are investigated different single countries and country groups with different variables but there are no studies focusing on Islamic emerging economies and comparing them with non-Islamic emerging economies. We believe that it is a research gap in the existing literature. This study provides a novel and comparative study to fill up this research gap.

The purpose of this study is to explain the association between CO2, economic growth, energy consumption, urbanization, and trade openness within the framework of the EKC hypothesis for 11 Islamic and 11 non-Islamic emerging economies in the period of 1990-2018. We employ Augmented Mean Group Estimator (AMG), Common Correlated Effects Mean Group Estimator (CCE-MG), and Mean Group Estimator (MG) to obtain panel and country-specific results.

In the first part of the study, we examined the literature and the studies done so far. The relevant literature has shown that our study is unique in terms of the selected country group. The second part deals with the perspective of Islam towards the environment. The econometric methods and data are stated in the third section. Empirical results are presented in the fourth section. The discussion and the conclusion parts are the last parts of the study.

Literature Review

Numbers of studies have been carried out on the relationships between economic growth, energy consumption, and environmental pollution since Kraft and Kraft's (1978) study. This study has been extended using novel variables, new countries or country groups, and up-to-date econometric techniques (Destek et al., 2018; Dogan & Inglesi-Lotz, 2020; Gormus & Aydin, 2020; Pata & Aydin, 2020; Yasin et al., 2020b; Yasmeen et al., 2020; Zameer et al., 2020). There are many studies that investigate the EKC hypothesis employing carbon emission. Özokcu & Özdemir (2017) examine the association between income, energy consumption and CO2 in the framework of the EKC hypothesis in the period of 1980-2010 for 26 OECD and 52 emerging economies employing panel data estimation techniques. The findings demonstrate that the EKC hypothesis is not valid for these countries.

Bölük and Mert (2015) tested the validity of the EKC hypothesis considering renewable energy and GDP during 1961-2010 for Turkey. Results from Autoregressive Distributed Lag (ARDL) approach shows that the EKC hypothesis was valid in Turkey during the period, and the turning point determined 9920 US Dollar. Jalil and Feridun (2011) examine the effect of economic growth and energy consumption on environmental pollution in China from 1953 to 2006 using ARDL. The results show that the EKC hypothesis is valid for China. Shujah-ur-Rahman et al. (2019) investigate the EKC hypothesis considering real income and energy consumption for Pakistan during 1970-2016. Results from the ARDL approach show that the EKC hypothesis is valid for the first case without interaction effect but not valid in second estimations with an interaction effect.

The EKC hypothesis is also tested for novel variables such as energy consumption, urbanization, and trade openness. Yasin et al.'s (2020) study investigates the effect of urbanization, trade openness, and energy consumption on the ecological footprints to check whether the EKC hypothesis is valid or not for 110 countries in the period of 1996–2016. Results from panel EGLS and multi-step A-B GMM show that the EKC hypothesis is valid in both developed and less developed countries. Yasin et al. (2020b) also examine the effect of urbanization, and trade openness on CO2 emission for 59 less-developed countries in the period of 1996–2016. Empirical results of A-B GMM confirmed the EKC hypothesis for these countries.

Zhang et al. (2017) investigate the validity of the EKC hypothesis considering trade openness, energy consumption, and economic growth in newly 10 industrialized countries between 1971 and 2013, employing A-B GMM model. The findings show that the EKC hypothesis is valid for these countries. In addition, trade openness is significant and negatively associated with CO2. Economic growth and energy consumption have a positive impact on CO2.

Al-Mulali and Ozturk's (2015) study is extended by Charfeddine and Mrabet (2017), adding ecological footprint to the EKC hypothesis. Considering energy consumption, economic growth, and urbanization for 15 MENA countries during 1975-2007, results from FMOLS and DOLS estimators demonstrate that the EKC hypothesis is valid for the whole sample. Contrary to expectations, urbanization is negatively associated with environmental degradation.

Moreover, the EKC hypothesis has been tested for different country groups such as Emerging economies, developed countries, less-developed countries, BRIC, G7, etc. To fill up the gap in the literature, our study focuses on the validity of the EKC hypothesis in Islamic and non-Islamic emerging economies. Bozoklu et al. (2019), Cetin (2018), Hove and Tursoy (2019), Yasin et al. (2020), and Raza et al. (2020) have investigated the validity of the EKC for emerging market economies with different variables and different periods. Bozoklu et al. (2019) examined the validity of the EKC hypothesis for 15 emerging

markets in the 1960-2014 period. The results from non-linear cointegration analysis show that the EKC hypothesis is valid for China, Colombia, India, South Korea, and the Philippines. Cetin (2018) investigated the EKC hypothesis in emerging markets and developed countries for the period from 1990 to 2011. Empirical results show that EKC is valid for only developed countries. Raza et al. (2020) tested the EKC hypothesis using panel data techniques in Next-11 and BRICS countries, also considered as emerging economies, in the period of 1990-2015. Empirical results support the EKC hypothesis in emerging countries. Hove and Tursoy (2019) tested the EKC hypothesis for 24 emerging markets in between 2000 and 2017 using panel GMM model. The empirical findings support the EKC hypothesis for emerging markets.

Shahbaz et al. (2016) investigate the causality among carbon dioxide (CO2) emissions, energy consumption, and economic growth taking into account the EKC hypothesis employing time-varying Granger causality in the Next 11 countries for the period from 1972 to 2013. The results indicate that the EKC hypothesis is valid for Indonesia and Turkey. The results also show that there is the unidirectional time-varying Granger causality running from economic growth to CO2 emissions in these countries.

Narayan and Narayan (2010) check the EKC hypothesis for 43 developing countries employing the panel cointegration and the panel long-run estimation techniques in the period of 1980–2004. Results showed that the EKC hypothesis holds only for the Middle Eastern and South Asian countries. Khattak et al. (2020) test the EKC hypothesis for BRICS employing CCEMG and AMG for the period of 1980–2016. The results show that the EKC hypothesis is valid for all the BRICS economies except for India and South Africa. Riti et al. (2017) test the validity of the EKC hypothesis for China over the period 1970–2015. The results confirm the validity of the EKC hypothesis.

Yavuz (2014) tests the EKC hypothesis for Turkey using the Gregory-Hansen cointegration technique in the period of 1960 to 1978 and 1979 to 2007. The results show that the EKC hypothesis is valid in both periods. Hasanov et al. (2019)'s results show that the EKC hypothesis for Kazakhstan is not valid in the period of 1992-2013.

Islamic Perspective on the Environment

Natural resources are considered as a valuable asset given by the earth to human beings play as a critical role in human society and economic development (R. Wang et al., 2019). According to the Islamic economy, all the natural resources are created by Allah and are devoted to humanity. Therefore, Muslims have to use these natural resources in line with Islamic economics rules.

In a broad definition, Islamic economics is the science that studies human behavior and economic problems based on Islamic perspectives such as the Qur'an, Sunnah, Ijma, and Qiyas. There are several differences between the

teaching of Islamic economics and Conventional economics. Contrary to Conventional economics, Islamic economics assumes the abundance of resources and the limited needs of people. Muslims are not only utilizing and managing the resources of the universe for their own benefit but also for the welfare of society. Also, Islamic economics try to maximize the utility of human both in the present world and in the hereafter.

Last three decades, environmental problems have increased due to mass production and construction. Conventional economics has developed a new discipline called "Environmental Economics" and published several academic journals to study all aspects of environmental problems. Despite these efforts, environmental problems continue to increase and become a threat to the universe. In contrast to Conventional economics literature, Islamic economics literature has made a relatively minor contribution to environmental problems. Most Islamic scholars have focused on the religious and moral aspects of the subject in general (Asutay, 2013; Goktas & Chowdury, 2019; Kamla et al., 2006). Islamic economics literature is far away from developing a discipline about the environment, offering practical solutions or policies to address the problem.

According to Islamic thought, One Supreme Being (Allah) created the whole universe in balance. Allah says in the Quran: "He created man and taught him clear expression. The sun and the moon both run with precision. The stars and trees bow down in prostration. He erected heaven and established the balance so that you would not transgress the balance. Give just weight; do not skimp the balance. "He" laid out the earth for all living creatures" (Al-Rahman, 55:3-9). As a part of the universe, environmental protection and balance become Muslim's religious duty (Akhtar, 1996). Therefore, Muslims are responsible for maintaining and conserving the environment for both current and future generations.

The excessive use of natural resources and waste productions are two leading causes responsible for an environmental imbalance in the universe. Since Islam emphasizes the benefit of society over the benefit of individuals, companies and individuals should protect and maintain the environment even if doing so negatively will affect their own benefits. Unfortunately, most of companies and individuals protect the environment from attracting environment-sensitive of customers and from avoiding fines instead of as a religious duty or moral responsibility (Salem et al., 2012).

The use of natural resources for production and consumption is allowed for "no injury or do no harm" criteria. According to Bani Sadr, those criteria have three dimensions Salem et al. (2012)

i. *Since One Supreme Being (Allah) created the whole universe in balance, any overuse of human and natural resources may create an imbalance in the universe and are prohibited by Islam. The Quran mentions that people are chosen as vicegerent of Allah, and they have to act as Allah asks them (Akhtar, 1996).*

ii. *Many traditions of the Prophet underline the fellow-feeling and brotherhood between Muslims. "A Muslim is a brother of another Muslim; he neither wrongs him nor leaves him without help" narrated by al-Bukhari (Al-Bukhari, 2020). In Prophet traditions, Muslims care for one another and guarantee that their actions will not harm others (Akhtar, 1996). Producers and consumers with the spirit of fellow-feeling and brotherhood do not base their production and consumption decisions on profit and utility maximization. Instead, they try to maximize society's welfare and not harm others. Hence, environmental problems such as global warming, pollutions will be reduced.*

iii. *As stated in the Quran, the conservation of natural resources is an obligation for all Muslims, and wastefulness is a sinful act in Islam. Allah says in the Quran: "O children of Adam! Wear your beautiful apparel at every time and place of prayer; eat and drink: But waste not by excess, for Allah loveth not the wasters." (Al-A'raf, 7:31). God created the whole universe and chose the Muslims as trusteeship. As a trusteeship, Muslims should act according to the wish of God. Muslims cannot waste resources and should protect the environment in any case. Also, the traditions of the Prophet orders Muslims not to waste and protect the environment. "There is none better amongst the believers who plants a tree from which a person, or an animal eats thereof. It is regarded as having given a charitable gift for which there is great recompense." narrated by al-Bukhari (Al-Bukhari, 2020).*

In addition to the above criteria, Muslims believe accountability in the afterlife. This belief will affect the decision of Muslims in such a way that tries to maximize welfare not only in this life but also afterlife (Shaikh, 2013). Therefore, afterlife accountability encourages positive change in the behavior of Muslims and thus helps him no harm to the environment.

Islamic financial instruments have developed, and environmentally friendly products have emerged. Green Sukuk can be given as an example of these products. Although they have a small share in the total Sukuk market, the interest in these products is increasing due to environmentally sensitive investments such as renewable energy projects (Campisi et al., 2018; Mat Rahim & Mohamad, 2018).

Data and Econometric Methods

Data

The data was collected from the World Bank's 2020 World Development Indicators data set. The data set includes 22 emerging markets countries for the period of 1990-2018. We select CO2 (metric tons per capita), energy use (kg

of oil equivalent per capita), and GDP per capita (constant 2010 US$) over the period. CO2 emissions are those stemming from the burning of fossil fuels, and the manufacture of cement, The GDP per capita is measured in US dollars at 2010 prices, and the Energy use is measured in kg of oil. Trade is the sum of exports and imports of goods and services measured as a share of GDP. The urban population refers to the percentage of people living in urban areas. Table 1 provides all these abbreviations.

Table 1. Abbreviations and Sources

	Description	Source
CO_2	CO2 emissions (metric tons per capita)	World Bank Development Indicators
Energy	Energy use (kg of oil equivalent per capita)	World Bank Development Indicators
GDP	GDP per capita (constant 2010 US$)	World Bank Development Indicators
Urbanization	Urban population (% of total population)	World Bank Development Indicators
Trade Openness	Trade (% of GDP)	World Bank Development Indicators

We classify Islamic countries depending on their membership of the Organisation of Islamic Cooperation (OIC). Turkey, Egypt, Iran, Kazakhstan, Kuwait, Qatar, United Arab Emirates, Saudi Arabia, Pakistan, Malaysia, and Indonesia are considered as Islamic emerging economies (Organisation of Islamic Cooperation, 2020). On the other hand, non-Islamic emerging economies were chosen depending on the non-Muslim population rate. With respect to this classification, Argentina, Brazil, Chile, China, India, Mexico, South Korea, Peru, Russia, Thailand, and Vietnam have more than %85 non-Muslim population over the total population, which are considered as non-Islamic emerging economies (Pew Research Center, 2017).

Table 2 shows a statistical summary associated with the actual values of three variables for each country group. When we look at the variables of the country groups, it is seen that there are huge differences between Islamic Emerging Economies and non-Islamic Emerging Economies. The highest means of CO2, energy use, and GDP per capita are in Islamic Emerging Markets.

Table 2. Descriptive statistics

Islamic Emerging Economies					
	CO_2	**Energy**	**GDP**	**Urbanization**	**Trade Openness**
Mean	13.89	4830.16	19312.04	66.78	80.13
Median	7.170	2522.33	8186.50	66.60	67.81
Maximum	70.04	22120.40	69679.10	100	220.41
Minimum	0.62	397.10	741	30.58	25.31
Std. Dev.	15.70	5236.33	21779.99	21.05	44.29
Jarque-Bera, Prob.	188.64***	116.90***	69.03***	16.17***	77.48***
Observations	319	319	319	319	319
Number of Countries	11	11	11	11	11
Non-Islamic Emerging Economies					
	CO_2	**Energy**	**GDP**	**Urbanization**	**Trade Openness**
Mean	4.10	1707.79	7193.62	63.36	59.38
Median	3.56	1413.73	7206.21	73.85	50.95
Maximum	13.98	5928.66	26761.90	91.87	208.31
Minimum	0.30	260.79	433.28	20.26	13.75
Std. Dev.	3.33	1392.32	5277.43	23.42	36.47
Jarque-Bera, Prob.	78.78***	106.99***	98.49***	41.26***	169.75***
Observations	319	319	319	319	319
Number of Countries	11	11	11	11	11

The values of the variables vary from country to country. Qatar has the biggest GDP per capita in all these countries. Qatar's energy consumption is the biggest in response to this; it is the biggest emitter of CO2 per capita in these 22 emerging markets, which are 11 Islamic and 11 non-Islamic emerging economies. Among non-Islamic emerging economies, South Korea has the highest GDP per capita; on the other hand, Russia has the highest energy consumption and the biggest emitter, CO2.

When we examine the data of the emerging markets, we find that countries have oil and natural gas reserves which use oil to produce energy. As a result, these countries provide energy production from oil and its derivatives, where CO2 rates are high.

Econometric Methods

The relationship between the CO2, Energy, GDP, GDP2, Urbanization, and Trade Openness for 11 Islamic and 11 non-Islamic emerging economies can be specified within the panel framework (Baltagi, 2013) as:

$$CO_{2it} = \alpha_{it} + \beta_1 Energy_{it} + \beta_2 GDP_{it} + \beta_3 GDP^2_{it} + \beta_4 Urbanization_{it} + \beta_5 TradeOpenness_{it} + \varepsilon_{it} \quad (1)$$

Where t =1990, 1991 ... 2018 and i= 1, 2, ... 11

T denotes the yearly time and i represents the individual country in this panel data model.

α_{it} is the constant. β_1, β_2, β_3, β_4 and β_5 are the coefficients of Energy, GDP, GDP2, Urbanization and Trade Openness, respectively. ε_{it} shows individual-specific error terms.

We provide the description of the variables as:

- CO_{2it} *: Carbon dioxide emissions (metric tons per capita)*
- $Energy_{it}$ *: Energy use (kg of oil equivalent per capita)*
- GDP_{it} *: Gross domestic product per capita (constant 2010 US$)*
- GDP^2_{it} *: Gross domestic product per capita square (constant 2010 US$)*
- $Urbanization_{it}$ *: Percentage of urban population*
- $TradeOpenness_{it}$ *: Trade is the sum of exports and imports of goods and services measured as a share of GDP.*

In this paper, we use the recently developed Augmented Mean Group Estimator (AMG) developed by Eberhardt and Teal (2010) and Eberhardt and Bond (2009) with common Correlated Effects Mean Group Estimator (CCEMG) proposed by Pesaran (2006) and Kapetanios et al. (2011). These two estimators consider cross-section dependence. We also employ Mean Group (MG) estimator introduced by Pesaran and Smith (1995) to compare the results.

Empirical results

Panel unit roots and panel cointegration tests

In panel data models, testing the stationarity of the variables is very common since the study of Granger and Newbold (1974). In their study, they claim that if all variables or their linear combination are not stationary, then this leads to the spurious regression problem. Moreover, Baltagi (2013) also claims the necessity of testing stationarity for panel estimations. Therefore, we firstly test the stationary properties of the relevant variables using the panel unit root test. To determine the type of the panel unit root test that we use in the model, we start to check for the absence of cross-section dependence across Islamic and non-Islamic emerging markets by applying the bias-adjusted LM test introduced by Pesaran et al. (2008). The results of the bias-adjusted LM tests are shown in Table 3.

Table 3. Panel unit root test results

Islamic Emerging Economies								
Variables	CIPS intercept	CIPS intercept + trend	Z_A^{SPC} intercept	Z_A^{LA} intercept	Z_A^{SPC} intercept + trend	Z_A^{LA} intercept + trend	LM_AD intercept	LM_AD intercept + trend
CO_2	-2.1751	-1.7672	1.978*	1.726*	0.655	0.727	128.238***	74.563***
Energy	-2.1192	-1.3722	-1.041	-0.575	-2.610	-0.268	87.673***	82.911***
GDP	0.1552	-1.3325	150.481*	451.212*	0.982	6.040*	88.521***	79.548***
GDP^2	0.3214	-0.7356	2.561*	31.440*	4.865*	12.966*	115.681***	102.896***
Urbanization	-1.4825	-2.4821	15.250*	22.048*	-0.326	-0.318	100.435***	96.645***
Trade Openness	-1.5510	-2.1948	1.389	-1.010	0.619	-1.979	99.076***	79.113***
Non-Islamic Emerging Economies								
Variables	CIPS intercept	CIPS intercept + trend	Z_A^{SPC} intercept	Z_A^{LA} intercept	Z_A^{SPC} intercept + trend	Z_A^{LA} intercept + trend	LM_AD intercept	LM_AD intercept + trend
CO_2	-2.5735	-2.7077***	-2.046	-1.944	-0.015	0.640	93.986***	89.646***
Energy	-2.0402	-1.7175	-2.214	-2.033	-1.117	0.495	95.514***	91.207***
GDP	-1.4168	-1.8029	0.804	8.785*	9.960*	48.471*	93.574***	89.561***
GDP^2	-1.0704	-1.3052	5.030*	17.150*	18.946*	71.683*	93.370***	88.458***
Urbanization	-1.7311	-2.2725	45.570*	43.610*	202.113*	740.386*	93.212***	87.299***
Trade Openness	-1.7449	-2.8327***	-2.318	-2.539	-0.380	-0.715	88.848***	85.264***

Notes: For the CIPS test the null hypothesis is nonstationary and for the Z_A^{SPC} and Z_A^{LA} tests the null hypothesis is stationarity. Critical values for the CIPS test are obtained from Pesaran (2007). The distribution of the Z_A^{SPC} and Z_A^{LA} statistics are asymptotically normal.

*, **, *** Indicates 10%, 5% and 1% level of significance, respectively.

According to this table, we reject the null hypothesis of no cross-section dependence. Thus, we use the CIPS tests as a second-generation panel unit root test by Pesaran (2007), which allows for the cross-section dependence to test search out if the variables are stationary or have a unit root. Similarly, we also use Z_A^{SPC} and Z_A^{LA} tests developed by Hadri and Kurozumi (2012) which allows for the cross-section dependence.

The results of the CIPS tests with Z_A^{SPC} and Z_A^{LA} tests are also shown in Table 3. These results show that we do not reject the null hypothesis of unit root in almost all cases so that variables have unit root. That is, all variables are the integration of order one in our model. Therefore, we employ error

correction-based panel cointegration tests introduced by Westerlund (2007) to test the cointegration among the variables. Besides this, Westerlund (2007) considers cross-section dependence (CSD) across the residuals. So, we firstly test the CSD and present the results in Table 4. According to this table, we find evidence of cross-section dependence across these residuals. This result justifies the use of Westerlund's (2007) panel cointegration tests. The results of these tests are also presented in Table 4. The test statistics in this table show that we reject the null hypothesis of no cointegration in all cases for both groups mean statistic Gt and panel statistics Pt, Pa in Islamic and non-Islamic Emerging Markets. Panel statistic Pa is the only insignificant statistic for both Islamic emerging economies. Hence, these four variables are cointegrated in Islamic and non-Islamic emerging markets, and we will employ the level of the variable for the rest of the study.

Table 4. Panel Cointegration Test Results

		Islamic Emerging Economies	Non-Islamic Emerging Economies
CSD for Cointegration	LM_AD	13.931***	22.968***
Panel Cointegration	G_t	-3.394**	-3.245***
	G_a	-10.198**	-7.162*
	P_t	-9.025*	-15.837***
	P_a	-4.758	-13.462***

*, **, *** Indicates 10%, 5% and 1% level of significance, respectively.

Slope homogeneity tests

In our model, we assume the slope heterogeneity among the 11 Islamic and 11 non-Islamic countries, so that we test this assumption by applying the Slope homogeneity test proposed by Pesaran and Yamagata (2008). The Slope homogeneity test results are illustrated in Table 5. The entire test results apart from $\hat{\Delta}_{adj}$ for Islamic and non-Islamic emerging markets reject the null hypothesis of the slope homogeneity. Thus, we can permit slope heterogeneity in the model. That is, we allow all the coefficients to vary across the Islamic and non-Islamic emerging markets. Therefore, we use AMG, CCEMG, and MG for each coefficient, as seen in detail in the next part.

Table 5. Slope homogeneity test results

Islamic Emerging Economies		Non-Islamic Emerging Economies	
Test	**Values**	**Test**	**Values**
$\widehat{S}$	106.5937***	$\widehat{S}$	71.3251***
$\tilde{\Delta}$	10.6160***	$\tilde{\Delta}$	9.8848***
$\tilde{\Delta}_{adj}$	12.3969***	$\tilde{\Delta}_{adj}$	11.5429***
$\widehat{\Delta}$	4.9193***	$\widehat{\Delta}$	1.5565*
$\hat{\Delta}_{adj}$	0.1816	$\hat{\Delta}_{adj}$	0.0434

*, **, *** Indicates 10%, 5% and 1% level of significance, respectively.

Estimation Results

We employ AMG, CCEMG and MG estimators for Islamic and non-Islamic emerging economies to obtain panel and country-specific results which are presented in Table 6 and Table 7, respectively.

Table 6. Islamic Emerging Economies Estimation Results

Countries	Energy	GDP	GDP^2	Urbanization	Trade Openness	Trend	EKC
Turkey							
MG	.0015848***	.0002816	-1.07e-08	.1968996	-.0097384	-.0934232	Not Valid
AMG	.0015705***	.0002829	-1.08e-08	.2031162	-.0090491	-.0976912	Not Valid
CCEMG	.0011617*	.0004821	-1.41e-08	.8874542	-.0208169*	-.7000375	Not Valid
Egypt							
MG	.0016853***	.0025839**	-5.15e-07**	.1059734	-.0059738*	.0052201	Valid
AMG	.0016733***	.0026335*	-5.21e-07**	.1542161	-.0064901*	.0053185	Valid
CCEMG	.0013939***	-.0029207	7.97e-07	-.2183863	-.0216836***	-.539858**	Not Valid
Iran							
MG	.0012837***	.0029476	-2.17e-07	.132916	-.0227582	-.0352902	Not Valid
AMG	.0011016**	.0029831	-2.26e-07	.2992741	-.0199339	-.1517792	Not Valid
CCEMG	.0014655***	.0033925	-2.85e-07	-2.010133*	-.0512166*	-.5748034*	Not Valid
Kazakhstan							

MG	.0031506***	-.0003795	2.58e-08	-2.11172	.0155131*	.1932712*	Not Valid
AMG	.0031899***	.0001225	-1.69e-08	-.6377418	.0075023	.1734742*	Not Valid
CCEMG	.003094***	.0024689*	-1.00e-07*	-14.38851**	.0325555**	1.841839*	Valid
Kuwait							
MG	.0015071***	.0023908**	-2.58e-08*	-2.696437***	-.1960876***	.2490532**	Valid
AMG	.0010866**	.0024715**	-2.63e-08**	-2.075281**	-.2025132***	.3301812**	Valid
CCEMG	.0005822	.0026103*	-2.20e-08*	-.2810271	-.2465345**	4.782328*	Valid
Qatar							
MG	.0026792***	-.0082199	5.49e-08	7.422037*	-.3649148*	-1.872448**	Not Valid
AMG	.0026325***	-.0020028	1.41e-08	1.184831	-.1340178*	.0083642	Not Valid
CCEMG	.0039199***	-.0048765	3.98e-08	.0579208	-.2228206*	-2.664127	Not Valid
United Arab Emirates							
MG	-.0001738	-.0003893	8.49e-09	-1.029047	.0360724*	.543624*	Not Valid
AMG	-.0002407	-.0008326*	1.34e-08**	.819343	.0300469	.1725241	Not Valid
CCEMG	-.0009526	-.0002577	1.05e-08	.3488087	.0218593	1.767136	Not Valid
Saudi Arabia							
MG	.0013437*	-.004617	1.52e-07*	1.144496	.0473099	-.3174013	Not Valid
AMG	.0018857**	-.0082675*	2.44e-07**	-3.288567	.0471624	.7982778	Not Valid
CCEMG	.0003852	-.0051795	1.86e-07*	-4.429722	.1137175	-.8004971	Not Valid
Pakistan							
MG	.0024434***	.0002796	-5.40e-07	-.4606241***	.0025785	.1158272***	Not Valid
AMG	.0023992***	.0004147	-5.79e-07	-.4175662**	.002733	.1054897***	Not Valid
CCEMG	.003692***	-.0002899	-6.79e-07*	-.2881326*	.0016967	.1061402*	Not Valid
Malaysia							
MG	-.0000592	.0038369***	-2.04e-07***	-.1927272	-.0102555	.2043072	Valid
AMG	-.0001185	.0040931***	-2.15e-07***	-.2144501	-.0095747	.2026367	Valid
CCEMG	.0002616	.0028158*	-1.92e-07***	.5778135	-.0128846	.6894872	Valid
Indonesia							
MG	-.0006757	.0016628*	-3.05e-07*	-.009748	-.0076017*	.0541362	Valid
AMG	-.0008656	.0019807*	-3.32e-07*	.0386449	-.0078491*	-.0040082	Valid

CCEMG	-.0029853*	.0010856	9.29e-08	-.4557903*	-.0039793	-1.044641*	Not Valid
Panel							
MG	.0013426***	.0000343	-1.43e-07**	.2274561	-.046896	-.0866476	Not Valid
AMG	.0013013***	.0003526	-1.50e-07**	-.3576528	-.027453	.1402534*	Not Valid
CCEMG	.0010926*	-.0000608	-1.51e-08	-1.836337*	-.0372825	.2602696	Not Valid

*, **, *** Indicates 10%, 5% and 1% level of significance, respectively.

Table 6 illustrates results for Islamic emerging economies. Energy consumption has a significantly positive correlation with CO2 in all countries and models except for Indonesia and Malaysia. There is a significant and negative relationship between urbanization and CO2 in all models (MG and AMG) only for Pakistan (Kuwait). In addition, there is a significant and negative relationship between urbanization and CO2 only in the CCEMG model for Iran, Kazakhstan, and Indonesia. Trade openness has a significantly negative relationship with CO2 in all models for Kuwait, Egypt, and Qatar. There is a significant and negative association between trade openness and CO2 in the CCEMG model for Turkey and Iran. On the other hand, we find a significant and positive relationship between trade openness and CO2 in the MG model for Kazakhstan and the United Arab Emirates. The results of the whole panel for Islamic emerging economies show that energy consumption has a significantly positive correlation with CO2 in all models and urbanization has a significant and negative association with CO2 only in the CCEMG model.

The results of the long-run coefficients of the model in Table 6 indicate that the EKC hypothesis is valid for Kuwait and Malaysia in all models, while it is valid for Indonesia and Egypt (Kazakhstan) in MG and AMG (CCEMG). This result illustrates that the EKC hypothesis, the inverted U shape relationship between CO2 and GDP, with the impact of urbanization and trade openness is not valid for the whole panel in all models.

Table 7. Non-Islamic Emerging Economies Estimation Results

Countries	Energy	GDP	GDP^2	Urbanization	Trade Openness	Trend	EKC
Argentina							
MG	.0016879***	.0006463***	-2.86e-08**	-.567724*	.0027933	.0915207*	Valid
AMG	.0012113***	.0006598***	-2.67e-08***	-.1841405	-.0034185	.055467*	Valid
CCEMG	.0014588**	.0004736*	-1.87e-08*	-.0597282	-.0102838*	-.2189201	Valid
Brazil							
MG	.0001325	.0001218	5.00e-09	.0916592*	-.0053606	-.041504	Not Valid

AMG	.0001736	.0001159	4.18e-09	.0907669*	-.0079351	-.0333615	Not Valid
CCEMG	-.000111	.000199	8.33e-09	-.0728263	.0150746 *	.733757***	Not Valid
Chile							
MG	.0009289*	.0006024*	-7.07e-10	.3029272	-.0110674*	-.196023*	Not Valid
AMG	.0008071**	.0012641***	-3.01e-08***	.022932	-.0342631***	-.0977404*	Valid
CCEMG	.0013088**	.0005765*	-2.20e-08*	.283941	-.0442836**	.1193274	Valid
China							
MG	.0001471	.0069042***	-4.76e-07***	-.3728963	.003978	-.198812	Valid
AMG	.0005163	.0082646***	-4.74e-07***	-1.3481**	.0228127	.6745059*	Valid
CCEMG	-.0010253	.0123424***	-4.90e-07***	-2.605797***	.0957365***	.6469743	Valid
India							
MG	.0012568*	.0019965	-1.36e-06***	1.046954**	-.024795***	-.1916038	Not Valid
AMG	.0017934**	.0002891	-8.79e-07*	1.01453**	-.0269241***	-.14321**	Not Valid
CCEMG	.0010755	-.0022759	-3.64e-07	1.232002	-.0162656	.1682705	Not Valid
South Korea							
MG	.0013413***	.0002332	-3.09e-10	.0844074	-.0074143	-.1094645	Not Valid
AMG	.0014081***	-.0005853	1.86e-08	.6084831	-.0142831	-.0899238	Not Valid
CCEMG	.0009056*	-.000285	3.59e-08	1.021138*	.0125197	.5519718	Not Valid
Mexico							
MG	.0029441***	.0000504	2.95e-09	.2519938*	-.0012582	-.0839739*	Not Valid
AMG	.002569***	-.0002969	2.51e-08*	.6132612**	-.0050516*	-.1810981**	Not Valid
CCEMG	.0018131***	-.0004175*	3.07e-08**	-.2953881	-.0036715	.0316794	Not Valid
Peru							
MG	.0010396*	.0017016*	-1.40e-07	.0044612	-.0109205	-.0360859	Not Valid
AMG	.0011937*	.0019119**	-1.78e-07*	-.1984071	-.0133806	.0639233	Valid
CCEMG	.001327	-.0004411	5.93e-08	-.4763104	.0035957	-.0936807	Not Valid
Russia							
MG	.0045847***	.001544	-9.39e-08	4.280718**	-.0744433***	-.2660247*	Not Valid
AMG	.003791***	.0016897*	-1.13e-07*	7.711778***	-.0642753***	-.1561535	Valid
CCEMG	.0016761	.0023774**	-5.95e-08	7.808022**	-.0691362***	3.118533***	Not Valid
Thailand							
MG	.0007026**	.0021458***	-2.34e-07***	-.0007403	-.0077127	.0601223*	Valid
AMG	.001001***	.0023555***	-2.18e-07***	-.0953239***	-.020557***	.1544184***	Valid

CCEMG	-.0003017	.0024111***	-1.64e-07**	-.0904291	-.0089975	.2945487	Valid
Vietnam							
MG	-.0010442*	.002772	-2.16e-06***	.887526***	-.0066437*	-.2952904***	Not Valid
AMG	-.0009862**	.0045272*	-1.59e-06***	.3279178*	-.0171357***	-.0544469	Valid
CCEMG	-.0009667*	-.002157	-2.17e-07	.2239888	-.0085568*	-.03112	Not Valid
Panel							
MG	.0012474***	.0017017***	-4.08e-07*	.5462987*	-.0129859**	-.1151945***	Valid
AMG	.0012253***	.001836**	-3.15e-07**	.778518	-.0167647**	.0174891	Valid
CCEMG	.0006509**	.0011639	-1.09e-07**	.6335103	-.0031153	.4837583*	Not Valid

*, **, *** Indicates 10%, 5% and 1% level of significance, respectively.

Table 7 illustrates results for non-Islamic emerging economies. Energy consumption has a significantly positive (negative) correlation with CO2 in all models for South Korea, Mexico, Argentina, and Chile (Vietnam). There is a significant and positive relationship between energy consumption and CO2 in MG and AMG models for India, Peru, Russia, and Thailand. There is a significant and positive relationship between urbanization and CO2 in all models (MG and AMG) for Russia (India, Brazil, Mexico, and Vietnam). However, there is a significant and negative association between urbanization and CO2 in AMG and CCEMG (AMG-MG) for China (Thailand-Argentina). Trade openness has a significantly negative relationship with CO2 in all models for Russia, Vietnam, and Chile. There is a significant and negative association between trade openness and CO2 in AMG (CCEMG) model for Mexico and Thailand (Argentina). However, we find a significant and positive relationship between trade openness and CO2 in the CCEMG model for China and Brazil. The results of the whole panel for non-Islamic emerging economies show that energy consumption has a significantly positive correlation with CO2 in all models. Trade openness (urbanization) has a significant and negative (positive) association with CO2 only in MG and AMG (MG) models. The results of the long-run coefficients of the model in Table 7 indicate that the EKC hypothesis is valid for China, Thailand, and Argentina in all models, while it is valid for Peru, Russia, and Vietnam (Chile) in AMG (AMG and CCEMG). This result illustrates that the EKC hypothesis, the inverted U shape relationship between CO2 and GDP, with the impact of urbanization and trade openness is (not) valid for the whole panel in AMG and MG (CCEMG).

Discussions

The effect of energy consumption on CO2 is positive, as expected in both country-specific and panel results. This result is consistent with the literature (Aydin & Turan, 2020; Destek et al., 2018; Dogan & Inglesi-Lotz, 2020; Gormus & Aydin, 2020; Pata & Aydin, 2020; Yasin et al., 2020b).

In non-Islamic emerging economies, the effect of urbanization on CO2 is positive for most country-specific and panel results as expected. These results are in line with previous studies. (Yasin et al., 2020b; C. Zhang & Lin, 2012). In Islamic emerging economies, however, the effect of urbanization on CO2 is negative for most country-specific and panel results (Charfeddine & Mrabet, 2017; Yasin et al., 2019). These results are contrary to expectations and the following reasons can explain it. Firstly, urbanization can provide high productivity using fewer resources to produce the same amount of goods due to the positive externalities and the economies of scale. Secondly, in Islamic emerging economies, the service sector developed more than the manufacturing sector with urbanization. The service sector less polluted environment than the manufacturing sector. If it is considered that some emerging Islamic economies are oil-rich and some of the popular tourism destinations, the results are not surprising. Due to these reasons, urbanization mitigates CO2 in Islamic emerging economies (Charfeddine & Mrabet, 2017).

The effect of trade openness on CO2 in most Islamic and non-Islamic emerging country-specific results is negative and significant. These results are consistent with the previous studies. In panel results, the effect of trade openness on CO2 is significant and negative in non-Islamic emerging economies, while it is insignificant and negative in Islamic emerging economies. (Aydin & Turan, 2020; Yasin et al., 2020a; S. Zhang et al., 2017).

The country-specific results within the framework of the EKC hypothesis show that the EKC hypothesis is valid for Malaysia and Kuwait in Islamic emerging economies and Argentina, China, and Thailand in non-Islamic emerging economies for all models. These results are supported by the previous studies (Bozoklu et al., 2019; Ike et al., 2020; Li et al., 2016; Raza et al., 2020; Suki et al., 2020). The panel results represent that the EKC hypothesis is not valid for Islamic emerging economies in all models while valid for non-Islamic emerging economies in MG and AMG models.

Conclusion and Policy Recommendations

This paper aims to investigate the association between CO2, economic growth, energy consumption, urbanization, and trade openness within the framework of the EKC hypothesis for 11 Islamic and 11 non-Islamic emerging economies from 1990 to 2018. We employ AMG, CCEMG, and MG estimators to obtain panel and country-specific results.

It is essential that whether the EKC hypothesis depends on the country group or not. Our empirical results from the panel show that the EKC hypothesis is valid for non-Islamic emerging economies but not valid for Islamic emerging economies. In Islamic emerging economies, the invalidity of the EKC hypothesis can be explained in several ways. First, these countries have a considerable amount of valuable natural sources such as oil and natural gas. Therefore, the

share of renewable energy on the total energy consumption is lower in Islamic emerging economies. In addition, these countries do not have an awareness of environmentally friendly energy consumption. The second, oil and natural gas-rich countries (Kuwait, Qatar, the UAE, and Saudi Arabia) have low-tech, which cannot improve energy efficiency.

The findings show that Islamic emerging economies need to do more work on environmental pollution. Islamic emerging economies should efficiently use natural resources towards reducing the environmental pollution. Our findings offer several policy implications to reduce environmental pollution in Islamic emerging economies. These countries should invest more in renewable energy and diversify energy sources. In addition, these countries should increase technology levels for energy-efficiency. At the same time, the awareness of environmentally friendly energy consumption should be instilled. These policy implications can help mitigate the pressure on environmental pollution in Islamic emerging economies.

The circular economy model has begun to be adopted by many countries today, and this model is similar to the Islamic economics system. Islamic countries should attach importance to the circular economy to prevent waste of resources and better resource utilization. Thus, environmental degradation will be reduced in Islamic countries. For future studies, Islamic emerging economies can be divided into sub-groups. This topic can be extended using different variables, different country groups, and different techniques.

Declarations

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Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

The datasets generated during the current study are available in the [World Bank Development Indicators] repository, [https://data.worldbank.org/].

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