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THE LINK BETWEEN ENERGY CONSUMPTION AND ECONOMIC GROWTH IN GCC COUNTRIES

Abstract

The purpose of this research article is to provide the fresh evidence on the link between energy consumption (ENE) and economic growth (GDP) while controlling for the impact of CO2 emissions (CO) in the case of GCC (Gulf Cooperation Council) countries. To conduct the empirical study we have employed the panel VAR methodology in the period 1980-2014. The results suggest that economic growth increases the energy consumption. However, the negative link between CO2 emissions and economic growth is reported, implying the great awareness of the GCC countries on the environmental problems connected with the fossil fuels based energy. Thus, there is a serious incentive in these countries to deal with the potential environmental issues. One of the good alternatives is renewable energy. In addition, the increase in the energy efficiency is considered to be an important task in the future.

Keywords: economic growth; energy consumption; Gulf Cooperation Council

JEL Classifications: O13; O44

Introduction

The energy consumption-growth nexus has received much attention among research community in the recent decades. However, this link has not been explored very intensively in the case of GCC countries what was the motivation to conduct this study at first. The additional motivation is connected to the fact that economic growth of these countries over performs the world average which has increased significantly the energy demand. Taking into account the fact that these countries have the significant resources of fossil fuels, this was not the problem at the first glance. However, the energy demand is higher day by day. Thus, GCC countries understood that the energy based on fossil fuels is not very good long-term solution. Besides that, the environmental concerns connected with the CO2 emissions caused by fossil fuels energy operated devices are rising at the global level. Asif and Muneer (2007) and Tuzcu and Tuzcu (2014) have also advocated the significant role of the fossil fuels in the environmental depletion.

With regards to the environmental concerns, it is important to emphasize the fact that GCC countries are among the top 14 produces of CO2 (https://www.irena.org/-/media/Files/IRENA/Agency/Factsheet/Renewable-Energy-in-the-Gulf.pdf) per capita. Moreover, Sarı and Soytaş (2009) outline the great exposition of these countries to the problems aligned with the climate change. Due to these issues, GCC countries make a significant effort to resolve the potential environmental issues. Thus, renewable energy is found as a good alternative due to the fact that sunshine duration is very high, thus there are great potentials for solar energy (Alnasaser and Alnaser, 2011). Besides solar energy, there are the great potential in terms of nuclear power as well as the wind and geothermal energy.

Al-Maamary (2017) outlines the fact that the Gulf countries are the central point in the world nowadays in terms of the energy supply. These authors show that these countries are the owners of almost 50% of the global oil reserves and almost 30% of the natural gas. In terms of Arab countries 16 out of 22 are the oil producers (Desai et al. 2009). Hence, the oil is found to be critical determinant of the economic growth of these countries. For the time being, these countries are the key oil suppliers. However, the oil situation is likely to change in the near future due to the fact that new significant oil reserves are discovered in the non-Arab countries. Thus, it is critical for GCC countries to look for the alternative energy sources for two reasons. First reason is to keep significant reserves of oil while spending the energy from other sources and the second reason is to deal with the potential environmental issues. As a possible alternative, GCC countries make a significant effort to find a financially viable solution. Taking into account the significant potential, renewable energy (especially solar energy) is found to be a good alternative to the fossil fuels based energy supply.

In terms of the renewable energy, significant steps have been conducted in the recent decades. These plans are in general connected to the solar energy. The second most popular is wind energy, while the third most popular is waste-to energy. However, the statistics in the last year of interest is not very affirmative. The share of the renewable energy consumption in the final energy is found to be 0 in most of the GCC countries (Bahrain, Kuwait, Oman and Qatar) according to The World Bank's data. This percentage is found to be lower than 1 in United Arab Emirates and Saudi Arabia. Despite to the fact that there are many ambitious projects in the region, the realization is weak and this is the point where policy makers in GCC countries should make a significant effort. However, it is easy to understand the low development of renewable energy in the countries of interest. There are the two important reasons, the first one is the lack of regulations that will promote the renewable energy and the second one is highly subsidized energy supply based on fossil fuels. Thus, to develop the renewable energy supply there is a need to deal with both of these issues. The contribution of this paper to the literature arises from the fact that this research includes the longer period of interest; it analyzes the current situation in terms of renewable energy and pays special attention to the role of CO2 emissions in GCC countries.

This research will thus present the link between energy consumption and economic growth in the case of GCC countries. In addition, it will advocate the problems associated with the CO2 emissions. It will try to answer the question where or not the governments of the selected countries are aware of the environmental depletion problems. Thus, after the introductory remarks we will provide a brief literature review on the matter. After that, methodology will be presented together with the variables of interest. At last we will present and interpret the results of the research and conclude in the last chapter.

Literature review

Kraft and Kraft (1978) were pioneers in the examination of the link between the consumption of energy and economic performance. Since 1980s, this link has received tremendous attention among research community. Kraft and Kraft (1978) investigated the relationship of interest and have only found the unidirectional causality running from the gross national product to the consumption of energy. More research has been conducted globally during the last three decades, including on several emerging countries, such as Asian countries; China, Malaysia, Turkey and the Gulf Cooperate

Countries (GCC). Although each of these studies used different empirical methods and tools, the results from this growing literature are mixed, as some studies found a causality relationship between energy consumption while others did not. It may be argued that the conflict between these results might be due to the different policy and regulations of each country. For example, Yoo (2006) did not find any causality between both two variables (economic growth and energy consumption) in Thailand and Indonesia, and he argued that results were due to the fact that people use electricity only for their basic needs.

In the context of this study, we have reviewed the most recent studies on the link between the consumption of energy and the growth of economy in the case of GCC countries. Thereby, more attention will be paid to the research by Farhani and Rejep (2012), Saatci and Durmrul (2013), Salahuddin et al. (2014), Saidi and Hammami (2015), Asif et al. (2015), Hamrita and Mekdam (2016), Magazzino (2016), Howarth et al. (2017), Bekhet et al. (2017), Keho (2017), Gambo et al. (2018), Naminse and Zhuang (2018), Zou (2018) and Nkengfack and Fotio (2019).

For example, Farhani and Rejep (2012) examine the relationship between energy consumption, real GDP and CO_2emissions in the following countries; Algeria, Cyprus, Egypt, Iran, Israel, Jordan, Kuwait, Morocco, Oman, Saudi Arabia, Sudan, Syria, Tunisia, Turkey and the United Arab Emirates, for the period 1973-2008. By applying dynamic ordinary Least Squares (DOLS) and Fully Modified Ordinary Least Squares (FMOLS), they concluded that there is a long-run unidirectional causality from GDP and CO_2emissions to energy consumption, while no short-run causality has been found from GDP to energy consumption.

In fact, structural breaks can be taken into consideration as an important factor that might affect the time series; for example, Saatci and Durmrul (2013) by using structural break they investigate the relationship between energy consumption and economic output in Turkey for the period 1960-2008.They find evidence of the positive relationship between energy consumption and economic growth. These findings are also confirmed by Apergis and Payne (2010) and Lim and Yoo (2011).

Yuan et al. (2014) by employing Toda-Yamamoto procedure with VAR model found a bilateral relationship between carbon emissions and GDP and unilateral causality running from CO_2 to GDP in China over the period of 1991-2011. His findings are in the line with other studies such as: Soytas and Sari (2007) and Zhang and Cheng (2009).

Ozturk and Al-Mulali (2015) find the positive relationship between the consumption of gas and economic growth in the long-run. Moreover, a bidirectional causal link is found by employing the Granger causality test. Moreover, the same results were found for 58 countries around the world by Saidi and Hammami (2015), who examine the effect of economic growth and CO_2 emissions on energy consumption based on large panel data for 58 countries using a dynamic panel data model. Their findings show that the relationship is significant and positive. Salahuddin et al. (2015) investigate the effect of real GDP, electricity consumption and financial development on CO_2 in GCC countries for the period 1980-2012. They employ the DOLS and FMOLS and reveal a bidirectional causal link between the growth of economy and the consumption of CO_2. These results are in line with Farahani and Rejep's (2012) study.

The paper by Asif et al. (2015) investigates the relationship between energy consumption, GDP, urbanization and CO_2 emissions for four GCC countries (except Kuwait) for the period 1980-2011. They find a long-run relationship between energy consumption, carbon emissions, urbanization and economic growth, with economic growth and energy consumption having a positive impact on CO_2. Rahman et al. (2016) analyzed the link between the consumption of electricity and economic growth using panel data for GCC countries. The data were collected for the period 1975-2012 by employing a PMG framework. They concluded that there is a long-term relationship between the variables of interest. Moreover, supportive evidence regarding the feedback hypothesis is provided by suggesting a bidirectional link between the variables of interest. The main policy implications suggest that the energy conservation policy may have a significant negative impact on economic growth. Supportive

evidence regarding these results is also provided by Tang et al. (2013) and Belaid and Abderrahmani (2013).

Hamrita and Mekdam (2016), in their study, discuss the link between the emission of greenhouse gases, the consumption of energy and the growth of economy in GCC in the time span between 2000 and 2011 by applying the bootstrap panel causality test. It is worth mentioning that the bootstrap panel test was proposed by Konya in 2006. Their findings differ among the GCC countries; for instance no evidence on the causal link is found for Oman, Saudi Arabia and Kuwait. However, a the case of Bahrain reveals a bidirectional link while economic growth is found to Granger cause the consumption of energy in the case of United Arab Emirates. Magazzno (2016) examines the relationship between GDP, CO_2 emissions and energy consumption in GCC countries for the period 1960-2013. His results show that energy consumption Granger causes economic performance in the case of Qatar, Kuwait and Oman. However, the evidence on causality is not found in the case of Saudi Arabia while economic performance is found to Granger cause the consumption of energy in the case of Bahrain. However, Sweidan and Alwaked (2016) aimed to provide empirical evidence of the link between growth and energy intensity in the sample of GCC countries. The authors collected the data for the period 1995-2012. They have employed the time-series econometrics models. The findings suggest a significant positive link between the variables of interest. The results stress the need to consider the role of CO2 in regards to fossil-fuel energy and environmental issues, as suggested by Lopez (1994) and Selden and Song (1995).

Bekhet et al. (2017) has investigated the potential dynamic link between the economic performance, the development of financial sector, the consumption of energy and the emission of greenhouse gases. The data are collected on an annual basis for the period 1980-2011. The authors employed the ARDL model. The variables are found to have a bidirectional link in the long-term for all countries of interest but for UAE. Thus, the findings advocate the significant role of financial development. Hence, it is crucial for financial systems to take into account the environmental concerns connected with CO2 emissions due to the fossil fuel-based energy supply. The aforementioned environmental issues are also noted by Reiche (2010). Another recent study by Howarth et al. (2017) explored the link of interest in GCC countries while considering the period between 1997 and 2015. They argue that, if the GCC countries reduce their reliance on oil and gas, this will change the relationship between GDP and energy consumption. They insist that the energy consumption and economic growth in these countries are strongly linked. The evidence on the causal link between the economic performance and the consumption of energy is found in the case of 59 economies by Keho (2017). He argues that the main factor of increasing the CO_2 emissions is the energy consumptions in the 5 panels.

Gambo, et al. (2018) by using the ARDL method find a direct link between the economic performance and consumption of energy in the case of Nigeria in short- as well as the long-term. Naminse and Zhuang (2018) showed that economic growth has a bidirectional relationship with coal energy consumption, while carbon emissions have inverted U-shaped link with per capita income in China over the period 1952-2012. Their results support the environmental Kuznets curve (EKC) hypothesis. Zou (2018) seeks to explore the potential link between the emissions of greenhouse gases, economic output and the oil prices in the case of USA. He argues that oil prices play an important impact on carbon emission. Findings of this study show that GDP has not had an impact on carbon growth while positive oil price shocks have negative impacts on carbon emissions. A recent study by Nkengfack and Fotio (2019) examine the relationship between economic growth, energy consumption and CO_2 for South Africa, Algeria and Egypt during 1971-2015. They found a positive short and long run relationship between energy consumption, GDP and carbon dioxide (CO_2) in all three countries. They reported that the main factors behind increasing the carbon emissions in these countries are; oil, coal and electricity. Taking into account the research interest, the effects of economic growth on energy consumption is expected to be positive in this research. However, special attention is also paid to the tendencies of GCC countries to provide a solution to environmental depletion.

Methodology and variables

Time-series data based research employs intensively the VAR models. The main assumption of these models is to operate with the variables that are not exogenous (i.e. to operate with endogenous variables). Panel VAR models became popular in the last few decades. These models are considered suitable to deal with the individual's heterogeneity (Abrigo and Love, 2016). These models also tend to decrease the number of restrictions while providing the empirical evidence on the dynamic interdependencies. One of the most important properties of this model is that it enables us to calculate the IRFs (impulse-response function). This is since these models can be easily transformed to the structural form. Despite to the criticism of this model, it is still used intensively while analyzing the link between the variables in the case when the research collects the panel data. The panel VAR models are in general formalized as (Eq. 1)

$$Y_{it} = Y_{it-1}A_1 + Y_{it-2}A_2 + \cdots + Y_{it-p+1}A_{p-1} + Y_{it-p}A_p + X_{it}B + u_{it} + \varepsilon_{it} (1)$$

where the response variables are denoted by Y_{it}, the dimension is found to be $(1 \times k)$; the main variables (exogenous) are presented by the symbol X_{it} with the dimension of $(1 \times l)$; the fixed effect of the dimension $(1 \times k)$ is expressed by the symbol ε_{it}. The individuals of interest are denoted by i and are in the range 1-N while period of interest ranges from 1 to T_i. The important assumptions for innovations can be expressed as: $[e_{it}] = 0, E[e'_{it}e_{it}] = \Sigma$ and $[e'_{it}e_{is}] = 0$ under the condition that t is bigger than s. To deal with the potential bias suggested by Nickell (1981), there is a necessity to employ the GMM estimation. This estimation is also expected to improve the efficiency.

As indicated above, this paper tends to explore the link between energy consumption and economic growth in the case of GCC countries while controlling for the impact of CO2 emissions. Thus, we will be estimating and interpreting the trivariate panel VAR models that can be expressed as (Eq. 2)

$$\boldsymbol{ENE_{it}} = \sigma + \sum_{i=1}^{k} \boldsymbol{\beta_i}\, \boldsymbol{ENE_{t-1}} + \sum_{j=1}^{k} \theta_j\, GDP_{t-j} + \sum_{m=1}^{k} \varphi_m\, CO_{t-m} + u_{1t}$$

$$\boldsymbol{GDP_{it}} = \alpha + \sum_{i=1}^{k} \beta_i\, ENE_{t-1} + \sum_{j=1}^{k} \boldsymbol{\theta_j}\, \boldsymbol{GDP_{t-j}} + \sum_{m=1}^{k} \varphi_m\, CO_{t-m} + u_{2t}$$

$$\boldsymbol{CO_{it}} = d + \sum_{i=1}^{k} \beta_i\, ENE_{t-1} + \sum_{j=1}^{k} \theta_j\, GDP_{t-j} + \sum_{m=1}^{k} \boldsymbol{\varphi_m}\, \boldsymbol{CO_{t-m}} + u_{3t}. (2)$$

Panel data have some advantages over the time-series data. Panel data easily deal with the heterogeneity among individuals. In addition, Canova and Ciccarelli (2013) suggest that panel VAR easily controls for the interdependencies that are static as well as the dynamic ones. In addition, these can also control for the heterogeneity and dynamics in the estimated coefficients. Thus, this paper follows the methodology explained by Love and Zicchino (2006).

The annual panel data are collected from The World Bank's database in the period between 1980 and 2014. The period is selected based on the data availability. Energy consumption is approximated using energy use (kg of oil equivalent per capita) and is denoted by ENE. Moreover, economic growth is approximated by GDP per capita (current US$) and is denoted by GDP (Muslija et al., 2017, Satrovic, 2018a). Lastly, CO2 emissions (metric tons per capita) are used as a proxy of CO2 emissions and is represented by CO. To employ panel VAR there is a need to test for the stationary properties of the variables and we have used the three commonly used tests for this purpose. In addition, it was necessary to determine the order of the panel VAR. For this purpose, Andrews and Lu (2001) proposes the MMSC selection criteria, and we have thus employed these.

Results of the research and discussion

The empirical analysis is conducted for the sample of GCC (Gulf Cooperation Council) countries. These countries are selected due to their significant reserves of oil. Thus, GCC countries are recognized as some of the biggest exporters of the oil in the world. However, it is well known nowadays that devices based on fossil fuels energy tend to produce significant amounts of CO2 causing serious environmental issues. Hence, we have explored the link between energy consumption, economic growth and CO2 emissions in the case of the countries of interest. The analysis starts by presenting the main measures of the descriptive statistics in the Table 1. In terms of the energy consumption per capita, the leading country is Qatar, on average. The second best with regards to the average value of ENE is Bahrain while the last ranked is Oman. There are significant differences among GCC countries in terms of the energy consumption per capita.

Table 1: Descriptive statistics

	Measur.	United Arab Emirates	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	Total
ENE	mean	9728.16	10594.28	8611.47	3386.97	17069.83	4821.56	9035.38
	sd	1603.06	1144.07	2394.78	1926.99	2176.81	1034.56	4770.43
	max	12087.10	12406.70	11544.20	6832.83	21959.40	6937.23	21959.40
	min	6938.02	7794.79	1322.23	802.92	13698.30	3192.87	802.92
GDP	mean	33003.38	13459.25	23192.78	10004.43	36678.51	12149.72	21414.68
	sd	7318.59	5753.65	14742.35	5890.82	26176.87	6077.32	16774.80
	max	45758.90	24983.40	55572.00	22134.80	88564.80	25303.10	88564.80
	min	21907.60	7041.57	5407.97	4691.19	12698.20	5823.48	4691.19
CO	mean	27.03	24.18	25.04	9.56	48.69	15.17	24.95
	sd	5.56	2.77	7.16	4.30	12.84	2.50	14.01
	max	35.89	29.99	34.04	17.08	70.14	19.53	70.14
	min	15.42	19.65	5.01	4.45	24.71	10.45	4.45

Source: Authors

When it comes to the economic growth, the significant differences are recorded between the GCC member states. On average, Qatar records the highest value of nominal GDP per capita. The second best is United Arab Emirates. However, the last ranked country is again Oman. For instance average nominal GDP per capita is more than 3 times higher than the one reported in Oman. Based on the previous two measures, it can be easily concluded that the Qatar is leading country in the both energy consumption and economic growth. The concerning fact is that it is also a leading country in terms of the CO2 emissions. The emissions of CO2 is fare above average and it is as fifth as the one caused by the last ranked country Oman. The second country that emits the highest maximum value of CO2 per capita on average isUnited Arab Emirates. However, this value is almost equal to the average value of GCC countries. Table 1 suggests a direct link between the variables of interest implying that the higher GDP is in general connected to the higher energy consumption as well as CO2 emission. This research moves forward to the estimation and interpretation of the unit-root test. Table 2 presents the obtained results.

Table 2: Unit-root tests

Trend included in the model	lnENE		D.lnENE		lnGDP		D.lnGDP		lnCO		D.lnCO	
Method	Stat.	p-value	Stat.	p-value	Stat.	p-value	Stat.	p-value	Stat.	p-value	Stat.	p-value
Levin–Lin–Chu (LLC) t* test	-2.65	0.004	-11.38	0.000	-3.26	0.001	-11.20	0.000	-3.28	0.001	-10.93	0.000
Im–Pesaran–Shin test	-1.22	0.112	-12.45	0.000	-0.69	0.244	-10.49	0.000	-3.54	0.000	-11.91	0.000
ADF – Fisher inverse chisquare	15.78	0.202	101.81	0.000	27.89	0.006	63.91	0.000	24.31	0.019	121.49	0.000

Source: Authors

The stationary properties are tested in the case of log levels as well as the first difference of the variables. Levin–Lin–Chu (LLC) t* test suggests the stationary properties of the energy consumption in the log level. However, the other two tests suggest no rejection on the null assuming the unit root. With regards to the other two variables, Levin–Lin–Chu (LLC) t* test and ADF – Fisher inverse chisquare suggest the stationary properties of economic growth. However, Im–Pesaran–Shin test provides the evidence on the unit root. In terms of the third variable, all three tests agree on the stationary properties. Since there is a need to have the variables that are integrated of the same order, we have tested for the stationarity properties of the first difference. All three tests agree on the rejection of null on unit root for all variables of interest suggesting the variables to be integrated of the order 1 for a 1% level of significance which enables us to proceed to the PVAR estimation. Beforehand, the order of VAR model are evaluated and presented in Table 3. Taking into account that the lowest values of MBIC, MAIC and MQIC are assigned with the first order, this paper will estimate and interpret the first order panel VAR model.

Table 3: The order of PVAR

Order	CD	J	J p-value	MBIC	MAIC	MQIC
1	0.145516	30.77018	0.280679	-108.524	-23.2298	-57.8305
2	0.239915	25.62007	0.108768	-67.2429	-10.3799	-33.4471
3	0.492905	7.082855	0.628493	-39.3486	-10.9172	-22.4507

Source: Authors

To increase the efficiency we have estimated and interpreted the trivariate panel VAR model while using GMM. The results are outlined in the Table 4.

Table 4: VAR model (trivariate – GMM estimation)

Independent variables	Dependent variables		
	D.lnENE	D.lnGDP	D.lnCO
$D.ENE_{t-1}$	-0.011 (0.077)	-0.043 (0.038)	0.231 (0.097)**
$D.lnGDP_{t-1}$	0.167 (0.083)**	0.129 (0.074)*	0.124 (0.064)*
$D.lnCO_{t-1}$	-0.250 (0.089)	-0.089 (0.043)**	-0.311 (0.126)**

Note: ***, **, * significant at 1%, 5% and 10% respectively.

Source: Authors

The results suggest a response of energy consumption to economic growth to be significant and positive meaning that in order to increase production in GCC countries, there is a need to employ more energy that is considered to be one of the most important factors of production nowadays. However, the response of energy consumption on CO2 emissions is found to be negative. Taking into account the fact that most of the energy supply is based on nonrenewable sources, these results are of great

importance for policy makers. It suggests that GCC countries are aware of the environmental depletion connected with the CO2 emissions connected with the consumption of fossil fuels energy. In terms of GDP, it is also found to respond negatively to the emissions of CO2 which supports the previous conclusion suggesting the great awareness of the GCC countries on the environmental issues connected with the fossil fuels energy. At last, CO2 is found to respond positively to the both energy consumption and economic growth advocating the fact that most of the energy in GCC countries is supplied from nonrenewable sources. To explore whether or not there are the difference between these links in the short- and long-run, we have estimated and presented impulse-response function. The evidence on the causal link is given in the Table 5.

Table 5: Results of the Granger causality tests

Equation	Excluded		
	D.lnGDP	D.lnCO	All
D.lnENE	4.047 (0.044)*	7.895 (0.005)	9.026 (0.011)
	D.lnENE	D.lnCO	All
D.lnGDP	1.232 (0.267)	4.307 (0.038)	10.638 (0.005)
	D.lnENE	D.lnGDP	All
D.lnCO	5.661 (0.017)	3.692 (0.055)	8.033 (0.018)

Note: * p-value

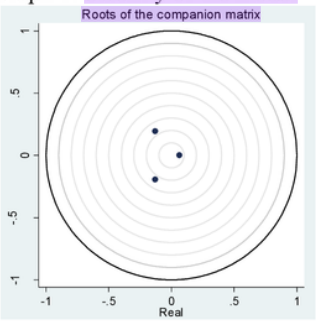
Source: Authors

The Table 5 outlines a unidirectional link running from GDP and CO to economic growth. The joint impact of these two variables on energy consumption is also found to be significant. With regards to the link between energy consumption and economic growth, there is no evidence on the causality. However, CO is found to have a causal impact. It is also important to emphasize that the joint impact of energy consumption and CO2 emissions on GDP is found to be significant implying the necessity to take into account the role of CO2 emissions while analyzing the energy-growth nexus in the case of GCC countries. At last, the Table 5 displays the unidirectional link running from energy consumption and economic growth to the emissions of CO2. Thus, the results suggest a bidirectional link between energy consumption and CO2 emissions. To test for the stability of the model, we have used tabular and graphical presentation. Table 6 and Graph 1 provide the supportive evidence to the assumption of the stability of the model taking into account that all eigenvalues lie within the unit circle.

Table 6: Stability of the model

Eigen value		
Real	Imaginary	Modulus
-0.1284	0.194128	0.23275
-0.1284	-0.19413	0.23275
0.063343	0	0.063343

Graph 1: Stability of the model



Source: Authors

To ease the interpretation, we have calculated and presented the forecast-error variance decomposition (FEVD) in the Table 7. This table suggests that 6.1% of the variability of energy consumption is explained by CO2 emissions and 0.8% is explained by economic growth. The rest is explained by the variable itself. In terms of GDP, energy consumption is found to explain 11.14% of the variability of economic growth while CO2 emissions are found to explain 1.3%. The rest is explained by the variable itself. With regards to the third variable, energy consumption is found to explain 24.7% of the

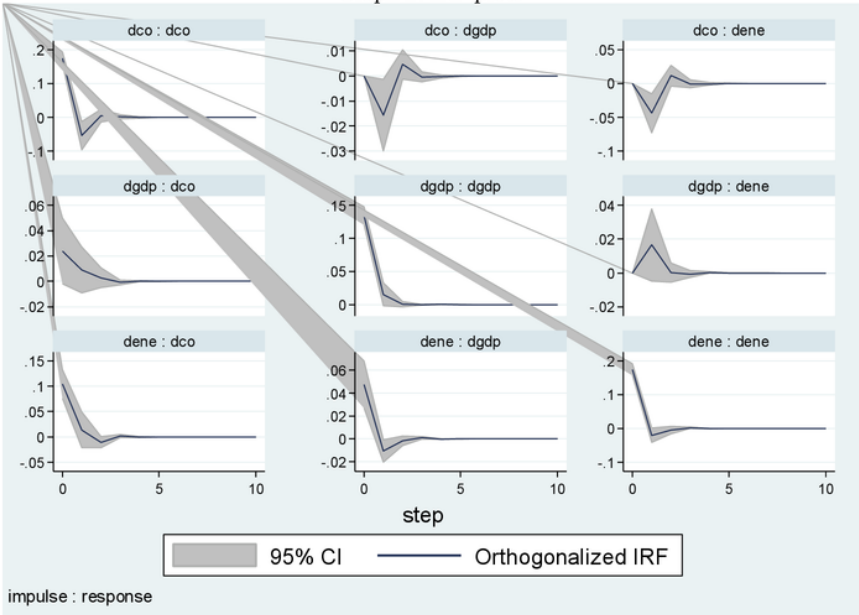
variability of CO2 while GDP is found to explain 1.5%. These results suggest the sensitivity of all of the variables of interest to the selection of determinants, thus the one should be very careful while selecting the proxy for all of the variables of interest.

Table 7: Forecast-error variance decomposition

Response variable	Impulse variable			Response variable	Impulse variable			Response variable	Impulse variable		
D.lnENE	D.lnENE	D.lnGDP	D.lnCO	D.lnGDP	D.lnENE	D.lnGDP	D.lnCO	D.lnCO	D.lnENE	D.lnGDP	D.lnCO
0	0	0	0	0	0	0	0	0	0	0	0
1	1	0	0	1	0.112	0.888	0	1	0.259	0.014	0.727
2	0.934	0.008	0.058	2	0.114	0.874	0.012	2	0.245	0.015	0.741
3	0.931	0.008	0.061	3	0.114	0.873	0.013	3	0.247	0.015	0.739
4	0.931	0.008	0.061	4	0.114	0.873	0.013	4	0.247	0.015	0.739
5	0.931	0.008	0.061	5	0.114	0.873	0.013	5	0.247	0.015	0.739
6	0.931	0.008	0.061	6	0.114	0.873	0.013	6	0.247	0.015	0.739
7	0.931	0.008	0.061	7	0.114	0.873	0.013	7	0.247	0.015	0.739
8	0.931	0.008	0.061	8	0.114	0.873	0.013	8	0.247	0.015	0.739
9	0.931	0.008	0.061	9	0.114	0.873	0.013	9	0.247	0.015	0.739
10	0.931	0.008	0.061	10	0.114	0.873	0.013	10	0.247	0.015	0.739

Source: Authors

Graph 2: IRF plots



Source: Authors

To conclude this empirical research, we present the results of impulse-response function. GDP is found to response negatively to the 1 standard deviation shock in CO in the first two years. After that, the impact appears to be positive for a short. However, it is not found to differ from zero in the long-run. Similar conclusion can be drawn for the response of energy consumption to the CO2 emissions. In terms of the other impacts, CO is found to respond positively to the GDP in the short-run while the long-run impact is not found to differ from zero. The similar conclusion can be drawn for the response

of energy consumption to GDP. In terms of the response of ENE to CO impact is found to be negative in the short-run. The same holds true for the response of GDP to ENE.

Conclusion

This research aimed to provide the fresh evidence on the link between energy consumption and economic growth in the case of GCC countries. The motivation arises from the fact that the energy demand has increased significantly in these countries due to the exponential economic growth in the period of interest (1980-2014). The average economic growth rate is fare above the world average. The rise in energy demand served as a warning sign for GCC countries. These have understood that the absolute dependence on the fossil fuels is not an appropriate long-term solution since the reserves of fossil fuels decrease on a daily basis and these are recognized as significant contributors to the CO2 emissions. Thus we have collected the annual panel data for the six GCC countries and have employed the panel VAR methodology.

Findings of panel VAR model display a response of energy consumption to economic growth to be significant and positive. However, the response of energy consumption on CO2 emissions is found to be negative. In terms of GDP, it is also found to respond negatively to the emissions of CO2. At last, CO2 is found to respond positively to the both energy consumption and economic growth advocating the fact that most of energy in GCC countries is supplied from nonrenewable sources. Granger causality test outlines a unidirectional link running from GDP and CO to economic growth. The joint impact of these two variables on energy consumption is also found to be significant. With regards to the link between energy consumption and economic growth, there is no evidence on the causality. However, CO is found to have a causal impact. It is also important to emphasize that the joint impact of energy consumption and CO2 emissions on GDP is found to be significant implying the necessity to take into account the role of CO2 emissions while analyzing the energy-growth nexus in the case of GCC countries. At last, the unidirectional link running from energy consumption and economic growth to the emissions of CO2 is reported.

The results of this paper are very promising. These suggest that GCC countries are aware of the environmental depletion connected with the CO2 emissions due to the consumption of fossil fuels energy. Before presenting the policy implications it is important to emphasize the fact that the countries of interest are one of the top 14 countries in terms of CO2 emissions at the global level. Thus, the awareness on the necessity to find a way to reduce CO2 emissions it is of great importance not only for these countries but also at the global level. The policy implication includes the necessity to first conduct research and development in the area of renewable energy (Satrovic, 2018b). Besides that, it is of great importance to attract the investments to this sector. Of the key importance is the adoption of renewable friendly regulations and subsidies. With regards to the renewable energy projects, it can be started with the small projects in the cities by installing a PV panels with water heaters operate by the solar energy. As the last recommendation there is a need to educate the citizensto make them understand better the advantages of renewable energy.

Thus, the recommendations for future research are to analyze separately the impact of non-renewable and renewable energy consumption on the economic growth in GCC countries. It is also of great importance to analyze the potential impact of these variables not only on economic growth but also on the standard of living. Besides that, the role of human capital can be of great importance. As a last recommendation, the sample size can be increased by introducing the OECD member states.

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