Alkasasbeh, Omar M.; Alassuli, Abdalla; Alzghoul, Amro

Article

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Energy Consumption, Economic Growth and CO_2 Emissions in Middle East

Omar M. Alkasasbeh*, Abdalla Alassuli, Amro Alzghoul

Faculty of Business, Amman Arab University, Amman, Jordan. *Email: o.kasasbeh@aau.edu.jo

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ABSTRACT

Energy consumption nowadays has become a global concern for excess Carbon dioxide emission. Excess CO_2 emission has created a major concern regarding global environmental sustainability. Middle Eastern countries are well-known for their energy production through fossil fuel consumption for the period of 1980-2020. The present research has focused on analysing the impact of CO_2 emission, energy consumption and economic growth in Middle Eastern countries. Five countries have been selected for this research United Arab Emirates, Iran, Kuwait, Qatar, and Turkey. Heterogeneity and cross-sectional dependency in the study variables were addressed using second-generation econometric approaches. The cointegration approach developed by Westerlund and Edgerton (2008) proved the existence of a long-run equilibrium among variables in the presence of structural breaks. Environmental carbon emissions rise as a result of economic growth The results prove that alternative sources of energy consumption should be employed to achieve environmental and economic sustainability.

Keywords: Economic Growth, Middle Eastern Countries, CO_2 Emission, Westerlund and Edgerton
JEL Classifications: Q43, Q53, Q56

1. INTRODUCTION

Middle-eastern countries have seen unprecedented growth in the sphere of economic development. They are countries that are heavily reliant on the "hydro-carbon rich economies." This particular region constitutes around 55% of the crude oil and 33% of the global natural gas. The overall relationship between total energy consumption and total CO_2 emission has been seen as positive. It is a testament to the importance of the region to meet the global energy demand (Aneja et al., 2017). It is not a hidden fact these resources are the main source of revenue in the region covering around 70% of the GDP in that region.

According to the studies of Muhammad, (2019), CO_2 emission in Middle East countries has been seen as high compared to other countries and this high CO_2 emission has resulted in poor energy consumption. Their studies have shown that the implementation of eco-friendly technologies can provide an effective solution to this problem. The region consists of twelve countries. Saudi Arabia is the largest exporter of oil. And Iran is the largest exporter of natural gas. An effective figure can be put forward in this particular scenario. The consumption of primary energy in the middle-eastern region was recorded at around 37 exajoules and it peaked in the year 2019 (37.7 exajoules).

It can be effectively said that climate change can be witnessed in recent times due to the enormous consumption of fossil fuels. It has systematically endangered humans and it put forward long-lasting changes in the natural arrangement at the same time. The emission of greenhouse gases has created unfavourable conditions for human health and it has deteriorated the quality of the environment as well (Ahmadi et al., 2019; Al-Kasasbeh et al., 2022).

The influence of the World Bank must be mentioned in this particular scenario that played an influencing part to promote green energy generation by putting forward loans with low interests.

Therefore, it can be effectively stated that 90% of the GHG emission is occurred due to energy consumption and production. It is not a brainer that the emission of GHG has maximised considerably in the last 30 years. The IEA put forward emphasis on the confiscation of subsidies in fossil fuel to mitigate the speed of "climate change" in the domain of middle-eastern countries. According to the "Carbon dioxide analysis centre," five middle-eastern countries top the "CO_2 emission per capita" list and it is a testament to the severe condition of the environment in those regions (Anwar et al., 2020) Moreover, the "carbon footprint" of those regions is also heavily disintegrated due to it. Therefore, sustainable development is required in the countries associated with the Middle Eastern domain. The energy that is employed to maximise the economic pull may improve the social and global status of the region. However, the environmental degradation it would bring about is enormous and long-lasting. The present research focuses on describing the role of CO_2 emission and economic growth of Middle East countries. The research also focuses on explaining different strategies that policymakers can take to improve the economic growth of countries.

2. LITERATURE REVIEW

2.1. Empirical Literature

Different researchers have shared their insights regarding mitigation strategies in their journals with respect to multiple cities based in America and Asia due to enormous industrial activities. However, it is interesting to note in this particular scenario there is hardly any "mitigation journal" available in the domain that addresses the issues associated with the Middle-eastern region. The wave of globalisation has efficiently enabled numerous developing countries based in the Middle East to inject a huge chunk of revenue into the global economy. It is essential to mention in this particular scenario that the demand for fleets and travelling is ever-increasing in the modern scenario. However, the lack of limited "transportation infrastructure" is posing a great threat in that domain (Muhammad, 2019).

According to the studies of Shahbaz et al. (2019), "Foreign Direct Investment" or FDI is one of the main responsible factors for the increased CO_2 emission in Middle East countries. Their studies have shown that "biomass energy use" effectively reduces energy emissions and promotes environmental sustainability.

Another study has been done by Al-Mulali and Che Sab, (2018), which depicts the relationship between energy consumption (electricity consumption) and economic growth. This study has been conducted on Middle East countries for a time period of approximately 10 years. Their results have shown that high energy consumption has a positive impact on the country's economic growth.

As per the viewpoint of Nathaniel et al. (2020), renewable energy source is a positive step for improving the economic growth of Middle East countries. Their studies have shown that high CO_2 emissions have placed a negative effect on the economic and environmental sustainability of Middle East countries. Countries such as turkey and Qatar have faced a major economic crisis.

Another research conducted by Kahia et al. (2019), shows the economic growth, total carbon dioxide emission rate and renewable energy consumption rate in 12 countries of the Middle East. Their studies have been conducted over a period of 1980-2012 and a PVAR model has been applied to prove the "bidirectional causality."

Another study has been done by Acheampong (2018) with the PVAR model to observe the relationship between total energy consumption, CO_2 emission and overall economic growth. This study has been conducted in over 114 countries in the Middle East. Their study has been conducted over the period of 1990-2014. Their results have shown that reducing CO_2 emissions has a positive impact on the environment and energy consumption.

The theoretical representation of the "Environmental Kuznets Curve" (EKC) puts forward an effective insight into this scenario. It said that the quality of the environment put forward a non-linear rendering of the economy. However, when a certain economic curve is outstretched, improvement can be witnessed as far as environmental quality is concerned. The importance of this theoretical representation is immense in the loping nations based in the Middle East. It means that it is a common pattern that degradation in air quality is inevitable in the developing stages of a nation. All the economic systems in developing countries may encounter a segment of "environmental correction." It shows the pattern where the revenue generation of the nation is influencing the incorporation of different environmental policies such as "New legislation regarding energy regulation." However, if that developing nation failed to incorporate the mitigating measures, an excessive bend on the curve can be witnessed and the rate of emission tends to maximise due to that (Jian et al., 2019).

2.2. Theoretical Literature

Due to globalisation, the GDP of middle-eastern countries have risen systematically. Additionally, the population explosion in recent times has systematically maximised the energy consumption of the nation (Ardakani and Seyedaliakbar, 2019). Data from 2014 effectively shows the energy consumption of the middle-eastern region is similar to that of 5% of the global energy consumption. It can be efficiently stated because of that the share of "domestic energy inculcation" has maximised from 5% to 20% in the last decade (Bekhrad et al., 2020).

It is essential to mention in this particular scenario that Middle-earning countries possess around 80% of the global crude oil. It enables the nations of that particular region to establish themselves in a unique stature in the global market. It is essential to mention in this scenario that Iran is the third-largest crude oil producer in the world. However, it is important to mention in this particular scenario that the life shelf of the oil is estimated at around 98 years.

Oil is considered one of the most influential components in the domain of Kuwait. However, all the oil reserves are around 55 years and it is detrimental to the future development of the country. Iran possesses around 11% of the global crude oil, whereas, Kuwait possesses around 8% of the global crude oil. It can be effectively commented that the economy of Iran, UAE and Kuwait are heavily dependent on oil and 85% of the national income is manoeuvred through oil and it almost constituted 55% of its GDP (Bhattacharya et al., 2017; Wasti and Zaidi 2020).On the other side, Turkey has contributed to having an enormous amount of oil reserves. The country has rank 53rd in oil reserves and approximately 43% of this oil is required to meet energy requirements in the country. Qatar has ranked 16th in oil reserves and is accounted for approximately 1.5% of the global oil reserve.

It is important to mention in this particular scenario that the oil production of UAE and Kuwait is increasing at a vehement rate. The maximisation rate is estimated at around 1.7%. The figure is estimated at around 2.3% in the domain of Iran. An interesting figure can be put forward in this particular scenario. The demand is ever creasing in the domain of UAE with a rate of 7.50%. It systematically demonstrates that growing prerequisites can pose a hurdle in the field of "sustainable carbon transition" in the incoming period (Ito et al., 2017).

An interesting perspective can be put forward in this particular scenario. Iran, UAE, Kuwait, Qatar and Turkey are the largest manufacturers and exporters of natural gas among all the countries associated with the domain of middle-eastern countries (Panigrahi et al., 2020). They contribute around 55% of the total exporters of this particular region. It can be stated without a doubt that Iran is the largest producer of "natural gas" globally. It alone produces around 20% of the global demand. UAE come in second place in terms of global demand (Charfeddine and Kahia, 2019).

The consumption ratio is maximising systematically in the domain of UAE and Iran. The maximisation is estimated at around 11% annually. An interesting fact can be put forward in this particular scenario that the life shelf of the natural gas reserve of Iran is around one hundred and 70 years. Whereas, demand has completely surpassed its consumption rate in the domain of Kuwait and it would pose a great challenge to meet the demand in the upcoming days. The carbon emission has systematically reached around 100 mt and the statistics show that the demand for natural gas would eventually surpass that of oil (Salahuddin et al., 2018).

According to the studies of Bayomi and Fernandez (2019), countries based in the middle-eastern region have the largest "fossil fuel reserves" in the world and it systematically influences their GDP. The GDP is heavily reliant on the injection of hydrocarbon elements. As effectively discussed in the theoretical framework, developing countries must adopt clean technology after reaching a critical point in the curve; UAE is following the same pattern based on that. They are heavily adopting technologies based on "carbon capture and storage" (CCS) to effectively manoeuvre the economic growth they have seen in the past decade.

In the past decade, the countries associated with the Middle-eastern region have witnessed a significant economic boost and it is a testament to the ever-increasing authority of those countries in the global political scene as far as energy demand and economic pull are concerned. In the last 45 years, the GDP rate of the countries in that particular region has systematically maximised with a ratio of around 3.8%. Whereas, production is maximised with an annual rate of 2.5% and energy demand is maximised with an annual rate of around 5.4%. The demand has also been maximised in the case of gas and natural oil. It is also estimated that the demand-pull of the region would reach around 1372.8 Mtoe with a maximisation rate of 2.4%.

3. THE MODEL AND DATA

The research focuses on describing the impact of CO_2 emission, energy consumption and economic growth. The data has been collected from World Bank Development Indicators (WDI).

We need the following variables for all studied Middle Eastern countries:

1. CO_2 emission (C);
2. Energy consumption (E);
3. Real GDP per capita (Y).

Our data are annual and cover the period 1980 to 2020 for the following Middle Eastern countries: United Arab Emirates, Iran, Kuwait, Qatar, and Turkey. Previous research shows that economic growth and energy consumption are big factors in CO_2 emissions (Wang et al., 2016). The econometric model was used to evaluate the relationship between CO_2 emissions, energy consumption, and economic growth. The effects of heteroscedasticity must first be excluded from the time series data before running series tests to estimate the association. This may be accomplished by taking the natural logarithm of the variables under study. The variables C, E and Y are measured in metric tons per capita, kt of oil equivalent per capita and constant 2010 international dollars respectively. The model used is specified as follows:

$$C_{it} = \beta_0 + \beta_1 E_{it} + \beta_2 Y^2{}_{\text{it}} + \beta_3 Y_{it} + \varepsilon_{it} \quad (1)$$

The coefficients β_1, β_2, and β_3 are, t is period, i is the cross section in the study. Table 1 shows the variables used in this analysis.

4. METHODS

This study may be carried out using the cross-sectional dependence of the model parameters, and the results will show whether the first or second generation of root unit tests is applicable. We conducted root tests of the second-generation unit in this study, which were validated by analysing cross-sectional dependency. The variables' integration order is provided by the unit root analysis, which also reveals the variables' stationary characteristics. When their integration characteristics are found, assess the long-term relationship between the variables in the presence of intersectional dependence. In order to find the proper policy measures for resolving the research problem, we must employ heterogeneous causality tests to address the bi-directionality of the policy measures, which is a broad methodological pattern of the study. In the following paragraphs, we document the tests' specifics.

4.1. Cross-Sectional Dependence Test

Panel data frequently exhibit cross-sectional dependency (CD) as a result of intra- and inter-country links. The estimates must be free from cross-sectional dependence to achieve consistent and unbiased results (Phillip and Sul, 2003). Therefore, it is imperative to test the cross-sectional relationship in the panel data. This study investigates CD through two tests, one suggested by Pesaran (2021) and the other by Breusch and Pagan (1980). The first cross-sectional dependence test, as proposed by Pesaran et al., (2004), can be written through the following equation:

$$CD = \sqrt{\frac{2T}{N(N-1)}}(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N} pij) \quad (2)$$

where T denotes the time period, N is sample size, j countries and pij indicates the correlation of errors of i.

The second cross-sectional dependence test is the Lagrange multiplier (LM), developed by Breusch and Pagan (1980). The equation below can be used to represent this test:

$$y_{it} = a_{\text{i}} + \beta_{\text{i}} x_{it} + \varepsilon_{it} \quad (3)$$

Where i denotes the cross-sectional proportions, and t is the length of time. The null assumption is that cross-sections are independent, while the alternative assumption is that cross-sections are mutually dependent.

4.2. Panel Unit Root Tests

It is important to examine the unit root before applying cointegration and regression techniques to investigate the equilibrium and long-run elasticities among the study's variables. Previously, the unit root test of the first generation, which does not account for cross-sectional dependence, was utilized. First-generation tests are ineffective because of their restricted capabilities (Dogan and Seker, 2016). This study consequently employs root tests in second-generation systems that understand the reliance on cross-sectional panel data. Using cross-cut IPS (CIPS) and center augmented Dickey-Fuller (CADF) approaches, this study investigates the unit roots in each component of the analysis. The results of these tests are reliable and can be utilized for further analysis.

4.3. Panel Cointegration Test

After confirming the cross-sectional dependence and unit roots in the panel data, the next step is to determine whether the variables are cointegrated. This study employs the cointegration technique suggested by Westerlund and Edgerton (2008). In its application, this test considers cross-sectional dependence and structural breakdowns. In addition, it permits heterogeneity in long- and short-term error correction models. This study used the coefficient (ϕN) and t-test version (τN) of cointegration tests, which are developed from the LM unit root tests. These two tests yield trustworthy findings for small datasets in particular.

4.4. Dumitrescu and Hurlin Causality Tests

The relationship between dependent and independent variables is demonstrated using long-term estimation techniques. However, knowing the direction of the short-term causal relationship between the variables is critical in policymaking. To accomplish this, we employ a causality check developed by Dumitrescu and Hurlin (2012) to determine the causal relationship between the variables. The vector autoregressive (VAR) approach on stationary findings is used to account for the data's unobserved heterogeneity. This test additionally runs the regression for each cross-section independently to establish the causal association between variables.

5. DISCUSSION OF RESULTS

Before we evaluate the stationary properties of the study variables, we test the presence of cross-sectional dependence in panel results. We used CD and LM methods for this evaluation, and Table 2 displays the results. These empirical findings show that cross-sectional dependence is observed between the cross-sections of the panel data by rejecting the null hypothesis. In the presence of cross-sectional dependency, the next step is to check the stable existence of each variable. We used CIPS and CADF tests for this purpose, and the results are recorded in Table 3. The empirical findings indicate that CO_2 emissions, energy consumption, and economic growth constitute the root problems at the regional level. However, there is no unit root at the first difference in such variables (stationary). In addition to the cointegration test findings in Table 4, We also performed the cointegration test described by Westerlund and Edgerton (2008) that addressed structural breaks. The experiments with a structural break conducted by Westerlund and Edgerton (2008) allow for the presence of cross-sectional dependency. The findings in Table 4 confirm the cointegration among CO_2 emissions, energy consumption, and economic growth.

Table 1: Variables description and data source

Variable	Abb.	Period	Source
Economic growth	Y	1980-2020	WDI
Carbon dioxide	C	1980-2020	WDI
energy consumption	E	1980-2020	WDI

WDI World Bank Development Indicators

Table 2: Cross-sectional dependence tests results

Variable	Breusch-Pagan LM	Pesaran scaled LM	Pesaran CD
Y	3157.80*	189.79*	55.17*
C	1325.19*“”	73.19*	12.71*
E	1603.11*	101.93*	37.07*

Table 3: CIPS and CADF unit root tests result

Variables	CIPS		CADF	
	At level	At first different	At level	At the first different
Y	−1.954	−3.882*	−2.012	−3.989*
C	−2.232	−4.557*	−2.219	−3.867*
E	−2.766*	−3.795*	−1.572*	−2.719*

*Denotes significant value at 1%

Table 4: Cointegration test results

Model	Test statistic (1)	P value	Test statistic (2)	P value
LMϕ	−2.354	0.010	−2.012	0.000
LMτ	−2.9116	0.003	−1.572*	0.000

Model (1): Model with a maximum number of 5 factors and no shift. Model (2): Model with a maximum number of 5 factors and regime shift

Table 5: Structural breaks of Westerlund and Edgerton cointegration test

Countries	No shift	Regime shift
UAE	1994	2004
Iran	1994	2000
Kuwait	1994	2005
Qatar	1994	2007
Turkey	1994	2014

Table 6: Pairwise Dumitrescu-Hurlin panel causality analysis

Null hypothesis	Causality	W-stat.	Zbar-stat.	Prob.
Y does not homogeneously cause C	Y↔C	4.589	1.295	0.112
C does not homogeneously cause Y		7.853	3.090	0.000
E does not homogeneously cause C	C→E	3.921	0.680	0.537
C does not homogeneously cause E		5.476	2.362	0.018
E does not homogeneously cause Y	Y→E	3.461	0.319	0.367
Y does not homogeneously cause E		4.814	2.072	0.049

Table 5 shows the structural fractures in the cross-sections of the data.

Table 6 exhibits the causality results of the Dumitrescu and Hurlin (2012) method. The result indicates that a bidirectional link exists between CO_2 emissions and economic growth. However, the causal link between energy consumption and economic growth is unidirectional at a 5% significance level. A similar relationship exists between CO_2 emissions and energy consumption at a 5% significance level.

6. CONCLUSION

The countries from the middle-eastern region have seen unprecedented economic growth in recent times. It not only maximises the demand for energy in that particular region but is also an enormous source of non-renewable sources of energy establishing them in a respectable position on a global map. However, Carbon emission has maximised significantly due to that. Therefore, the middle-eastern country must incorporate a renewable source of energy into their activity. Moreover, the incorporation of "clean technology" can also play a significant role in shaping up the future economy of the region. The systematic investment in renewable sources of energy such as solar and wind would effectively reduce the heavy reliance on fossil fuels of the region.

The governments of those regions cannot sit tight in this particular situation and they must put forward projects to address the minimisation of pollution levels. Involving themselves in international trade is a potent method to transfer potent technologies and subscribe to the maximisation of employing renewable energy. This is the only way to sustain while meeting up the ever-increasing demand of the region and reducing carbon emission at the same time.

The motivation behind this study is the environmental concern in the middle-eastern countries, and as a result, the study spans the Middle Eastern nations from 1980 to 2020. The goals of this study were attained by utilising various econometric methods. For instance, unit root properties are examined using the CIPS and CADF techniques, while cointegration is examined using the Westerlund and Edgerton (2008) panel cointegration approach.

Finally, panel causality is checked through heterogeneous panel causality. The study's findings can aid in developing a thorough policy framework for achieving the SDGs so that the framework can absorb the negative externalities generated by the current policies, while not harming the pattern of economic growth.

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