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The Relationship Between High-Income Countries in Middle East and North Africa on Energy Consumption and Increase in Gross Domestic Product

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Abstract

Electricity, which emerged as a secondary energy source, has been one of the important input items in production since its widespread use. In this study, it is analyzed in 7 countries (Bahrain, United Arab Emirates, Israel, Qatar, Qatar, Kuwait, Oman and Saudi Arabia) in the high-income Middle East and North Africa (MENA) countries group. Using data on public and commercial services, residential, industrial, total other sectors (agriculture, transportation), total electricity consumed and GDP for the period 1990-2021, the relationship between sectoral electricity consumption and economic growth is analyzed with the Panel Granger causality test. As a result of the analysis, while there is no long-run relationship between public and commercial services, residential, total other sectors (agriculture, transportation) and total electricity consumed and growth, there is no causality relationship between these variables, while there is a unidirectional causality relationship from growth to electricity consumption in industry. Contrary to previous studies, the reason for the absence of a causality relationship from electricity consumption to GDP growth in this study is that export revenues from natural resources and high-tech products make a significant contribution to the GDP formation of the countries included in the analysis. These results show that, contrary to the same directional relationship between electricity consumption and GDP growth in the literature, it is not valid for natural resource and high technology exporter countries. We can say that the results of the study make an important contribution to the literature in this respect.

Keywords: Electric Consumption, Growth, MENA, Granger Causality Analysis.

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1. INTRODUCTION

Energy has been one of the key factors for the development and improvement of humanity since the early days of human history. Since the early stages of evolution, the energy used has varied as primary and secondary energy sources. For example, primary energy sources are coal, crude oil, natural gas, and uranium while secondary energy sources are diesel, electricity, petrol, and air gas. The industrial revolution increased the search for different energy sources as the demand for energy, along with the industrial revolution. The increase in energy demand has led to many conflicts as one of the key inputs for production. Energy demand from countries entering the fast growth process after World War II raised energy's importance (Yilmaz and Sensoy, 2022a.). While only the words land and natural resources were used substituted for the energy concept until 1970, the same concept started to be used in conjunction with the Neoclassic economics school (Common and Stagl, 2005.).

Energy input costs have increased with the oil crisis in 1970 as well as the importance of energy. Research on the effects of energy on economic growth also coincides with this period. Kraft and Kraft (1978) pioneered this area through their studies of the causal relationship between energy and economic growth. Immediately after, studies by Dunkerley (1982), Hamilton (1983), Burbidge and Harrison (1984), Ebohon (1996), and Templet (1999) revealed a causal relationship between energy consumption and growth. The literature regarding growth has been differently evaluated in many studies. These studies, in general, are about the relationship between energy consumption and economic growth; the growth hypothesis is limited to the savings, neutral, and feedback hypotheses. For findings, an increase in the growth hypothesis causes an increase in real GDP; an increase in real GDP causes an increase in energy consumption in terms of the saving hypothesis. Again, it is pointed out that there is no causality between energy consumption and real GDP in terms of the neutral hypothesis while there is a two-way causality relationship between energy consumption and real GDR regarding the feedback hypothesis. The feedback hypothesis suggests a bi-directional causality relationship between energy consumption and real GDP (Usta and Can, 2017.).

The study will investigate the causality relationship between industrial consumption and GDP in selected high-income MENA countries during the 1990-2019 period in which a small number of studies were made research objects.

Since the focus of the studies in the literature is total energy consumption and economic growth, our study is expected to have an original value in terms of being conducted within the scope of the variables of settlement, public and commercial services, other sectors (agriculture, transportation), the total electricity and GDP data for the 7 high-income MENA countries (Bahrain, United Arab Emirates, Israel, Qatar, Kuwait, Oman, and Saudi Arabia). The study's hypothesis is structured as “there is a positive relationship between electricity consumption and GDP growth”. The validity of the hypothesis was tested by utilizing the respective countries' data with the Panel Granger causal test method. This paper consists of two main sections: The subject was reviewed in the first section, and the second chapter

shows the econometric model, dataset, and experimental analysis results. The evaluation of the results is in the conclusion part.

2. LITERATURE

The method determined and the period studied have a variable effect on the results (Yilmaz & Sensoy, 2022b, p. 105). Therefore, when examining the literature, it is very important to specify the period under review.

After the study by Kraft and Kraf (1978) study on the causality relationship between electricity consumption and economic growth, academic interest started to increase. The relationship between electricity consumption and growth has become more widespread with studies on different analysis methods, regions, and periods. A significant part of the work results in a causality relationship between electricity consumption and economic growth.

Since the causality relationship between GDP growth and electricity consumption was scrutinized, the literature review of this paper was performed through studies on the causal relationship between GDP growth and electricity consumption in selected MENA countries and chronological ranking. Thus, over time, it will be easily noticed by which method the studies on these two variables research countries and regions and whether there are differences between the electricity consumption and GDP relationship specific to the region or country.

Akarca and Long (1980) examined the empirical relationship between gross energy inputs and GDP, using data from 1900-1974 in the United States, and determined that causality was only one-way from GDP to energy, and there was no causality from energy to GDP in the post-war period.

Terzi (1998) analyzed the relationship between GDP and sectoral electric consumption via the data between 1950-1991 in Turkey; for findings, there is a two-way causality between both GDP and total electric consumption and GDP and electric consumption at the sectoral level.

Ferguson, Wilkinson and Hill (2000) investigated the relationship between electricity consumption and economic development with data from more than 100 countries for the period 1971 and 1995. According to the results, there is a strong correlation between electricity consumption and wealth creation for the global economy.

Ghosh (2002) studied the relationship between electricity consumption per capita and GDP per capita via annual data covering the 1950-1997 period in India. For the results, there is no long-term balance between variables while there also is a one-way Granger causality relationship from GDP to electricity consumption without any feedback effect.

Soytas and Sari (2003) analyzed the relationship between energy consumption and GDP regarding G-7 countries and also 10 countries in emerging markets excluding China. They expressed based on the results that there is a two-way causality in Argentina while there is a causality from GDP

to energy consumption in İtaly and Korea while a causality from energy consumption to GDP was observed in Turkey, France, Germany, and Japan.

Yoo (2005) found a two-way causality between electricity consumption and economic growth at the end of his study with the annual data covering the 1970-2002 period in Korea.

Lee (2006) studied the relationship between GDP and energy consumption for 11 large industrialized countries, except for the UK for the period 1990-2012. According to the results, energy consumption and GDP are neutral concerning each other except for the UK, Germany, and Sweden; there is a two-way causality in the USA while there also is a one-way causality from energy consumption to GDP in Canada, Belgium, Netherlands, and Switzerland.

Yoo (2006) studied the causality relationship between electricity consumption and economic growth using annual data covering 1971-2002 regarding four members of the South East Asian Union (ASEAN) Indonesia, Malaysia, Singapore, and Thailand. There is two-way causality between electricity consumption and economic growth in Malaysia and Singapore, Indonesia, and Thailand; again there also is a one-way causality relationship from economic growth to electricity consumption without any feedback.

Jobert and Karanfil (2007) reviewed the causality relationship between GDP and energy consumption in the long term for Turkey with the annual data covering the 1960-2006 period. The GDP and energy consumption seem neutral both at the total and industrial levels. At the same time, they identified instantaneous causality between energy consumption and GDP, and simultaneous values are related at the same time.

Kar and Kinik (2008) studied the relationship between total and industrial electricity consumption, residential electricity consumption, and economic growth in Turkey with annual data covering the 1975-2005 period. The study concluded that the long-term relationship between total, industrial and residential electricity consumption and economic growth moves from electricity consumption to economic growth. They also found a two-way causality between residential electricity consumption and economic growth.

Narayan and Prasad (2008) researched the relationship between electricity consumption and real GDP for 30 OECD countries with data between 1960 and 2002. According to the results, energy-saving policies in Australia, Iceland, Italy, Slovak Republic, Czech Republic, Korea, Portugal, and the United Kingdom negatively affect real GDP in relevant countries while real GDP is not affected for the other 22 countries.

Bowden and Payne (2009) scrutinized the causality relationship between energy consumption and real GDP by using the data from 1949- 2006 in the USA and total and sectoral primary energy consumption criteria within a multivariate framework. They concluded that there is no causality between real GDP with total and transportation primary energy consumption while there is a two-way causality

between real GDP and primary energy consumption in industrial and domestic primary energy consumption.

Narayan, Narayan and Popp (2010) reviewed the long-term causality between electricity consumption and real GDP for 93 countries with data from the 1974-2002 period. According to the findings, there is a two-way Granger causality relationship outside the Middle East, where causality only works from GDP to electricity consumption. They also found that the increased electricity consumption in the six most industrialized countries would reduce GDP.

Yoo and Kwak (2010) studied the short and long-term causality relationship between electricity consumption and GDP by using annual data covering the 1975-2016 period of Argentina, Brazil, Chile, Colombia, Ecuador, Peru, and Venezuela. For Argentina, Brazil, Chile, Colombia, and Ecuador, the study found a one-way and short-term causality between electricity consumption to real GDP and a bi-directional causality relationship between electricity consumption and GDP in Venezuela. Furthermore, the study also found no causal relationship in Peru.

Apergis and Payne (2011) examined the relationship between electricity consumption and economic growth between 1990-2006 and data from 88 countries divided into four groups high, upper-middle, lower-middle, and low-income. Bidirectional causality between electricity consumption and economic growth in the short and long run, unidirectional causality from electricity consumption to economic growth in the short run, bidirectional causality in the long run for the lower-middle-income country panel, and one-way causality from electricity consumption to economic growth for the low-income country panel.

Shahbaz, Tang and Shabbir (2011) researched the relationship between electricity consumption, economic growth, and employment in Portugal with the data between 1971-2009. They found that electricity consumption, economic growth, and employment are integrated and that there is bidirectional Granger causality between three variables in the long term.

Gross (2012) examined the annual data covering the 1970-2007 period in the United States and the relationship between energy consumption and growth in the industrial, trade, and transport sectors. They found a one-way long-term Granger causality in the commercial sector from growth to energy and a two-way long-term Granger causality in the transport sector.

Zhang and Xu (2012) made a survey to examine the relationship between energy consumption and economic growth from regional and industrial angles for China with the annual data for the 1995-2008 period. The study found similar results in the Eastern Region and across the country in which there is two-way causality between energy consumption and economic growth.

Abbas and Choudhury (2013) studied the causality between electricity consumption and GDP for India and Pakistan with data from the 1972-2008 period. For their findings, there is a two-way

causality between agricultural electric consumption and agricultural GDP in India while the causality in Pakistan is from agricultural GDP to agricultural electric consumption.

Tang and Shahbaz (2013) examined the causality relationship between total and industrial electricity consumption levels and real output for Pakistan with annual data for the 1972-2010 period. They emphasized at the end of the study that there is a one-way Granger causality from total electricity consumption to real output and that the industrial level of electricity consumption causes real output in the production and service sectors. Still, there is no causal relationship between electricity consumption and real production in the agricultural sector.

Şahbaz and Yanar (2013) examined the causality relationship between real GDP, total energy consumption, and sectoral energy consumption with the annual data of Turkey for the period 1970-2010. It was found at the end of the analysis that there is a one-way causality from real GDP to total energy consumption. Again, there is a one-way causality relationship from GDP to energy consumption in transport, agriculture, and cycle power plant (CES) sectors on a sectoral basis. A two-way causality relationship is observed among the non-energy sectors while there is no causality relationship between industrial and residential energy consumption and GDP.

Hamdi, Sbia and Shahbaz (2014) examined the relationship between electricity consumption, foreign direct investment, capital and economic growth using GDP, electricity consumption, foreign direct investment and capital data of the Kingdom of Bahrain for the period 1980Q1-2010Q4 and found that electricity consumption, foreign direct investment and capital contribute to economic growth and that there is a feedback effect both between electricity consumption and economic growth and between foreign investment and electricity consumption.

Karanfil and Li's (2015) scrutinized the short and long termed Dynamics between electricity consumption, energy dependency, urbanization level, and economic activities using electricity consumption per capita and GDP data per capita for 160 countries for the period of 1980-2010. Countries in the relevant study were divided into subgroups based on income levels, regional locations, and OECD membership. They concluded at the end of the study that electricity consumption and the GDP relationship are related to regional differences, urbanization, and the income level of countries.

Kayıkçı and Bildirici (2015) studied Gulf Arab countries and some Middle East and North African countries. The study found a causality relationship between annual data from 1972-2011 and oil consumption, electricity consumption, and economic growth. For their findings, oil consumption, economic growth, and electricity consumption are consistently similar while the causality directions of countries differentiate based on their natural resource levels.

Kim (2015) reviewed the relationship between electricity consumption and economic development with data from 109 countries between the years 1971-2009. The relationship between

electricity consumption and economic development is quite similar to the relationship between per capita electricity consumption and per capita income.

Bernard and Kenneth (2016) investigated the relationship between economic growth and fossil energy sources consumed by the industrial, agricultural, transportation, trade, and housing sectors in Nigeria for the period 1990-2013. They concluded that all variables significantly contribute to the economic growth in Nigeria, but the housing sector contributes more to economic growth than other sectors.

Osman, Gachino and Hoque (2016) made a survey to analyze the relationship between economic growth and electricity consumption for the Gulf Co-operation Council (GCC) countries for the period 1975-2012. For their results, there is a two-way causality between economic growth and electricity consumption in relevant countries.

Abdouli and Hammami (2017) examined the relationship between economic growth, foreign direct investment inflows, and energy consumption using data from 17 MENA countries for the period 1990-2012. They found at the end of the analysis that there is a one-way causality relationship between energy consumption and foreign direct investment inflows.

Maksimovica et al., (2017) studied economic growth based on electricity production data from coal, hydroelectric, natural gas, nuclear, petroleum, and renewable sources and electricity consumption from different sources for EU countries for the period 1994-2007. According to the results, electricity consumption from renewable sources has the highest impact on economic or GDP growth forecasts.

Usta and Berber (2017) reviewed the effect of industrial energy consumption on economic growth with the annual data in Turkey for the 1970-2012 period. They pointed out at the end of the research that there is a two-way causality between energy consumption and economic growth in the transport and industrial sectors while there is no relation between energy consumption and economic growth in the agricultural and housing industries.

Koç and Saidmuradov (2018) studied the republics of Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan) for the causality relationship between these variables using electricity consumption, direct foreign investment and economic growth with data covering the period between 1992-2014. The study revealed a one-way causality between direct foreign investment, economic growth, and electricity consumption. They found no causality between economic growth and electricity consumption to direct foreign investment. For their findings, oil consumption, economic growth, and electricity consumption are consistently similar while the causality directions of countries differentiate based on their natural resource levels.

Fan and Hao (2020) examined the relationship between renewable energy consumption, foreign direct investment and gross domestic product using data on per capita gross domestic product, per capita foreign direct investment and per capita renewable energy consumption of 31 Chinese provinces

between 2000-2015, 3 variables in the long-run and stable equilibrium relationship, and that in the short-run, FDI will not cause a significant change in renewable energy consumption, while in the long-run, a moderate slowdown in GDP growth and targeted FDI will lead to a significant increase in renewable energy in China.

Tayyar (2019) reviewed the causality relationships between total electricity consumption and real GDP data and electricity consumption on economic growth in terms of sectors in addition to electricity consumption in Turkey's annual commercial, lighting, residential, official, and industrial sectors covering the period 1970-2017. According to the results, there is a two-way causality between the electricity consumption of commercial, residential, and industrial sectors and economic growth.

Koç (2020) investigated the effect of electricity consumption on economic growth by using the data of real national income per capita, transportation, services, industry, and agriculture belonging to 132 countries between 2010 and 2016. There was found a positive relationship between electricity consumption in transportation, industry, agriculture, and services and economic growth.

Bulut (2020) examined the relationship between sectoral electricity consumption and economic growth by using the annual data of industry, housing, services, transportation, agriculture, and livestock sectors for Turkey for the period 1990-2014. According to the results, while electricity consumption in housing and services and agriculture and livestock sectors affect economic growth negatively, electricity consumption in industry and transportation sector affects economic growth positively.

Cadirci and Guner (2020) studied the relationship between the electricity consumption of 81 provinces of Turkey between 2004-2016 in official institutions, industry, businesses, residential and other sectors (agricultural irrigation, street lighting, etc.) and the economic growth of the provinces in the long term. They found a significant and positive relationship between the electricity consumed in businesses and residences and the real GDP of that province in the long term while electricity consumption of all sectors had positive and significant coefficients in the short term.

Basar, Tosun and Bartik (2020) researched the relationship between industrial electricity consumption and growth with annual data in Turkey for the period 1990-2018. They concluded that the effect of electricity consumption in the household and lighting sectors on growth is positive, while the effect of electricity consumption in the industrial sector is negative.

Hızarcı and Zeren (2020) examined the relationship between financial development and electricity consumption using electricity consumption and GDP data of G-20 countries excluding Russia, the European Union, Canada and the United Kingdom for the period 1980-2016 and found that there is no co-integration relationship between electricity consumption and financial development, but there is bidirectional causality between these two variables.

Chandio et al. (2020) examined the relationship between electricity consumption, foreign direct investment and economic progress in Pakistan by using GDP, electricity consumption and foreign direct

investment data for the period 1997-2017 and found that there is a significant long-run link between both electricity consumption and foreign direct investment and economic development.

Azam et al. (2021) examined the impact of renewable electricity consumption on economic growth by using economic growth, renewable electricity consumption, non-renewable electricity consumption, non-renewable electricity consumption, gross capital formation, labor force and trade deficit data of 10 newly industrialized countries (Brazil, China, India, Indonesia, Malaysia, Mexico, Philippines, South Africa, Thailand and Turkey) between 1990-2015, they also found that all the variables examined have a positive long-run effect on economic growth and that a 1% increase in renewable and non-renewable electricity consumption increases economic growth by 0.095% and 0.017%, respectively.

Baydoun and Aga (2021) examined the impact of economic growth, financial development and globalization on CO2 emissions using economic growth, CO2 emissions and energy consumption data of the Gulf Cooperation Council (GCC) countries between 1995 and 2018 and found that economic growth and energy consumption reduce environmental sustainability, while globalization improves it, and that there is a feedback causality relationship between economic growth and CO2 emissions and between financial development and CO2 emissions.

Belal, Ahmed and Boujedra (2021) examined whether there is a short-run and long-run causality between housing, industry and economic growth by using residential, industrial electricity consumption and GDP data of Saudi Arabia between 1990-2019 and found that there is a unidirectional relationship from economic growth to industrial electricity consumption, while there is no relationship between residential electricity consumption and economic growth.

Agboola, Bekun and Joshua (2021) examined the relationship between energy consumption, oil rent, total natural resource rent, economic growth and CO2 emission data of Saudi Arabia between 1971-2016 and found that there is a long-run equilibrium relationship between these variables and that there is a feedback relationship between energy consumption and economic growth, while there is unidirectional causality between energy consumption and CO2 emissions.

Saidi, Montasser and Doytch (2022) examined the relationship between foreign direct investment, electricity consumption and financial development by using GDP, foreign direct investment and electricity consumption data of GCC countries between 1990-2019 and found that there is bidirectional causality between foreign direct investment and financial development, as well as unidirectional causality from electricity consumption to foreign direct investment and from financial development to electricity consumption.

Shameem P, Villanthenkodath and Chittedi (2022) examined the relationship between economic growth and sectoral electricity consumption by using India's annual sectoral electricity consumption and real GDP per capita data covering the years 1971-2019 and found that electricity consumption has a

positive effect on economic growth in the industrial and service sectors, while it has a negative effect in the agricultural sector.

Fernandes (2023) examined the relationship between sectoral energy consumption and economic growth using energy consumption data of industrial, residential, service and agricultural sectors of China, India, Indonesia, Malaysia, the Philippines and Thailand between 1990-2018 and found that industrial energy consumption is cointegrated with economic growth for China and India, agricultural energy consumption and economic growth are cointegrated for Indonesia and Thailand, the variables are cointegrated in the service sector for the Philippines, agricultural growth causes energy consumption and agricultural energy consumption causes growth in Indonesia and Thailand. Fernandes also found that industrial growth leads to energy use in India and the Philippines while the opposite is the case in China, economic growth in the service sector leads to energy use in the Philippines while the opposite is the case in Malaysia.

It is seen when the current literature is reviewed that studies generally focus on OECD, G7-G20 countries, industrialized countries, ASEAN, South America, Europe, Central Asia, and the MENA region. In the analysis, variables such as total energy consumption, public energy consumption, agricultural energy consumption, residential energy consumption, energy consumption in transportation, energy consumption in the service sector, and GDP are used. Unlike the general literature, this study analyzes the relationship between electricity consumption and GDP growth in 7 high-income MENA countries, which is not discussed much (6 countries that obtain a significant part of their GDP through the export of natural resources and Israel, which obtains a significant part of its income from high-tech products). It is expected that this study will make a unique and different contribution to the literature since selected MENA countries exhibit different characteristics from the economies of countries or regions examined in general.

3. ECONOMETRIC METHODOLOGY

In this study, the seven countries in the MENA group were analyzed on the sectoral electricity consumption-GDP relationship between 1990-2021, using public and commercial services, residential, industry, other sectors (agriculture, transportation) electricity consumption, and total electricity consumption and GDP data. As mentioned in the Data and Analysis section, Westerlund (2007) was used since there is a correlation between units in the error correction model of the countries, and Panel Granger tests were used due to the heterogeneity of the VAR model. Westerlund (2007) proposed 4 error correction-based cointegration tests that show a suitable small sample and high power characteristics compared to residual-based cointegration tests.

$$\Delta Y_{it} = \delta_i' d_t + \alpha_i Y_{it-1} + \lambda_i' X_{it-1} + \sum_{j=1}^{p_i} \alpha_{ij} \Delta Y_{it-j} + \sum_{j=0}^{p_i} \gamma_{ij} \Delta X_{it-j} + \varepsilon_{it} \quad (1)$$

In model number 1 $d_t = (1, t)'$vector expressing deterministic components $\delta_i = (\delta_{1i}, \delta_{2i})'$is the vector of coefficients expressing the coefficients associated with the deterministic components. In order to develop group mean statistics used for heterogeneous panels, model #1 is the appropriate delay length asp_i first step it is estimated by the Least Squares (Least Squares) method after. In the second step, it is estimated as $\alpha_i(1) = 1 - \sum_{j=1}^{p_i} \alpha_{ij}$. In the last step, the group mean statistics are calculated using the expression $\hat{\alpha}_i(1)$.

$$G_\tau = \frac{1}{N}\sum_{i=1}^{N} \frac{\hat{\alpha}_i}{SE(\hat{\alpha}_i)} \quad G_\alpha = \frac{1}{N}\sum_{i=1}^{N} \frac{T\hat{\alpha}_i}{\hat{\alpha}_i(1)} \tag{2}$$

This $SE(\hat{\alpha}_i)$, $\hat{\alpha}_i$'denotes es the standard error. Panel statistics used for homogeneous panels are also calculated in 3 steps. In the first step, latency's appropriate length is determined asp_i suitable models are estimated, and the remainings are calculated as follows.

$$\Delta\tilde{Y}_{it} = \Delta Y_{it} - \delta^{\hat{}}{}_{i_t}{}^{\hat{}}{}_{i_{it-1}} \Sigma_{j=1}^{p_i} \hat{\alpha}_{ij} \Delta Y_{it-j} \Sigma_{j=0}^{p_i} \hat{\gamma}_{ij} \Delta X_{it-j} \tag{3}$$

$$\tilde{Y}_{it-1} = Y_{it-1} - \delta^{\hat{}}{}_{i_t}{}^{\hat{}}{}_{i_{it-1}} \Sigma_{j=1}^{p_i} \hat{\alpha}_{ij} \Delta Y_{it-j} \Sigma_{j=0}^{p_i} \hat{\gamma}_{ij} \Delta X_{it-j} \tag{4}$$

In the second step, by using $\Delta\tilde{Y}_{it}$ and $\tilde{Y}_{it-1}$statistics, the error correction parameter $\hat{\alpha}$and standard error are calculated.

$$\hat{\alpha} = \left(\sum_{i=1}^{N} \sum_{t=2}^{T} \tilde{Y}_{it-1}^2 \right)^{-1} \sum_{i=1}^{N} \sum_{t=2}^{T} \frac{1}{\hat{\alpha}_i(1)} \tilde{Y}_{it-1} \Delta\tilde{Y}_{it} \tag{5}$$

$$SE(\hat{\alpha}) = \left((\hat{S}_N^2) \sum_{i=1}^{N} \sum_{t=2}^{T} \tilde{Y}_{it-1}^2 \right)^{-1/2} \quad \hat{S}_N^2 = \frac{1}{N}\sum_{i=1}^{N} \hat{S}_i^2 \textit{ olmak üzere} \tag{6}$$

In the last step, panel statistics are calculated as follows (Westerlund, 2007.).

$$P_\tau = \frac{\hat{\alpha}}{SE(\hat{\alpha})} \quad P_\alpha = T\hat{\alpha} \tag{7}$$

The Panel Granger Causality Test is a causality test using homogeneous panels. The first equation of Panel VAR and $Y$and X including slight stationary variables, can be stated like in equation 8.

$$Y_{it} = \alpha_i + \sum_{k=1}^{K} \gamma_k Y_{it-k} + \sum_{k=1}^{K} \beta_k X_{it-k} + \varepsilon_{it} \tag{8}$$

The main hypothesis of the Panel Granger Causality Test is $H_0: \beta_k = 0$. For Wald tests, the hypothesis is not deniable. Xvariable to$Y$indicate that there is no correct causality to the variable. (Yerdelen, 2017.).

4. DATA AND ANALYSIS

In some cases, the dimensions of the horizontal slice and time series data may not be sufficient in econometric analysis. This issue has increased the importance of panel data usage since 1950, and panel data has become very important. The use of panel data has required the consideration of heterogeneity and interunit correlation during test selection in econometric analysis. Due to the analysis of heterogeneous panel data with the methods developed for homogeneous panels results in deviated and inconsistent estimates, and the analysis of panel data with cross-unit correlation with methods that do not take into account inter-unit correlation resulting in ineffective estimates (Yerdelen, 2017.). This article is tested at each stage of the analysis to see if the data has heterogeneous and cross-unit correlations.

In the analysis, N=7 and T=32 total of 224 observations were used. The variables used are GDP, public and commercial service sector energy consumption (public), residential energy consumption (residential), other energy consumption (other), and total energy consumption (total). The time range of the data covers the years 1990-2021, the data were obtained from the World Bank and the International Energy Agency. The large time dimension necessitated unit root tests at first in the analysis. Before proceeding to the unit root tests, the natural logarithms of the series were taken to ensure stationarity in the variance. It is observed when the series graphs for each unit are examined that they generally have a constant but do not have a clear trend.

For this reason, the Dickey and Fuller (1979) specification used for homogeneity and inter-unit correlation testing contains constants. The appropriate number of lags was selected for each variable with the help of Akaike's (1974) information criterion.

Accordingly, the specification for the GDP variable is

$$\Delta lngdp_{it} = \alpha_1 + \beta_1 lngdp_{it-1} + \varepsilon_{1it} \quad (9)$$

and other variables are

$$\Delta lnpublic = \alpha_2 + \beta_2 lnpublic_{it-1} + \theta_2 \Delta lnpublic_{it-1} + \varepsilon_{2it} \quad (10)$$

$$\Delta lnresidential_{it} = \alpha_3 + \beta_3 lnresidential_{it-1} + \theta_3 \Delta lnresidential_{it-1} + \varepsilon_{3it} \quad (11)$$

$$\Delta lnother_{it} = \alpha_4 + \beta_4 lnother_{it-1} + \theta_4 \Delta lnother_{it-1} + \varepsilon_{4it} \quad (12)$$

$$\Delta lntotal_{\ it} = \alpha_5 + \beta_5 lntotal_{\ it-1} + \theta_5 \Delta lntotal_{\ it-1} + \varepsilon_{5it} \quad (13)$$

formed accordingly.

The cross-unit correlation and heterogeneity test of the estimated results of these models were performed, respectively, by Pesaran, Ullah and Yamagata (2008) and Swamy (1970). The results are summarised in the table below.

Table 1. Proper Unit Root Test Selection

Name of Variable	Pesaran, Ullah ve Yamagata (2008) Test Statistics	Swamy (1970) Test Statistics	Proper Unit Root Test Selection
lnpublic	11.85*	33.09**	Im, Pesaran and Shin (2003)
lngdp	171.5***	11.01	Breitung (2000) (Robust)
lnother	-4.66***	45.93***	Peseran (2003)
lnresidential	15.79***	69.24***	Peseran (2003)
Industry	-5.352***	34.76***	Peseran (2003)
lntotal	5.499***	93.05***	Peseran (2003)

The results obtained with the appropriate panel unit root tests are summarized in the table below.

Table 2. Panel Unit Root Test Results

Name of Variable	Appropriate Panel Unit Root Test Statistics	Result
lnpublic	-1.0332	I(1)
lngdp	2.2527	I(1)
lnother	-2.215	I(1)
lnresidential	-2.123	I(1)
lntotal	-1.924	I(1)

Whether the variables act together, in the long run, can be tested with panel cointegration tests. In order to decide cointegration variable and including the error correction model specification used,

$$\Delta Y_{it} = \alpha_j + \beta_j \Delta X_{jit} + \theta_j \Delta Y_{it-1} + \delta_j \Delta X_{jit-1} + \phi_j Y_{it-1} + \lambda_j X_{jit-1} + \varepsilon_{jit} \quad (14)$$

and formed accordingly. Pesaran, Ullah and Yamagata (2008) and Swamy (1970) tests were applied to the residues obtained from the solution of this model. The results are shown in the table below.

Table 3. Selection of Appropriate Cointegration Test

Variables	Pesaran, Ullah and Yamagata (2008)Test Statistics	Swamy (1970) Test Statistics	Appropriate Cointegration Test
lngdp-lnpublic	100.5***	43.29	Robust Westerlund (P_τ and P_α Test Statistics)
lngdp-lnindustry	111.9 ***	47.90	Robust Westerlund (P_τ and P_α Test Statistics)
lngdp -lnresidential	109***	53.30**	Robust Westerlund (G_τ and G_α Test Statistics)
lngdp -lntotal	71.44***	1422,59***	Robust Westerlund (G_τ and G_α Test Statistics)

Table 4. Panel Cointegration Test Results

Variables	Robust Westerlund (2007) Test Statistics		Result
lngdp-lnpublic	P_τ	-3.253	No cointegration relationship.
	P_α	-3.804	
lngdp-lnother	P_τ	-3.656	No cointegration relationship.
	P_α	-2.820	
lngdp -lnresidential	G_τ	-0.929	No cointegration relationship.
	G_α	-5.465	
lngdp-lnindustry	P_τ	-3.253	No cointegration relationship.
	P_α	-3.804	
lngdp -lntotal	G_τ	-1.212	No cointegration relationship.
	G_α	-5.183	

According to the test statistics of Westerlund (2007) which considers the inter-unit correlation, no cointegration relationship was observed between the variables.

In order to decide on the Panel Vector Autoregressive (Panel VAR) model to be established for short-term causality analysis, information criteria and appropriate lag length were investigated.

According to this, the appropriate latency length for lngdp-lnkamu variables is 2, for others are 1. $Y = \text{lngdp}$, $X_1 = \text{lnpublic}$, $X_2 = \text{lnresidential}$, $X_3 = \text{lnother}$ and $X_4 = \text{lntotal}$, lngdp-lnpublic $i = 1,...,7$ The appropriate panel VAR model for the industry variable is as follows

$$\Delta Y_{it} = \alpha_2 + \beta_2 \Delta X_{2it-1} + \theta_2 \Delta Y_{it-1} + \delta_2 \Delta X_{2it-2} + \phi_2 \Delta Y_{it-2} + \varepsilon_{2it} \quad (15)$$

for other variables, and will be appropriate panel VAR model defined as;

$$\Delta Y_{it} = \alpha_1 + \beta_1 \Delta X_{1it-1} + \theta_1 \Delta Y_{it-1} + \varepsilon_{jit} \quad (16)$$

Swamy's (1970) test was applied to the residuals obtained as a result of the estimation of the Panel VAR models established with the appropriate lag length. According to the results of the Swamy (1970) test, it was determined that the appropriate causality test was the Panel Granger causality test. The results are summarised in the tables below.

Table 5. Appropriate VAR Model Selection

Variables	Latency Length of Appropriate VAR Model	Swammy's S Test Statistics
lngdp-lnpublic	1	15.60
lngdp-lnother	1	10.02
lngdp -lnresidential	1	8.67
lngdp -lnindustry	2	15.62
lngdp -lntotal	1	22.90

Table 6. Panel Granger Causality Test Results

Variables	Panel Granger Test Result	
lngdp-lnpublic	dlnpublic →dlngdp	0.224
	dlngdp→ dlnpublic	1.992
lngdp-lnother	dlnother →dlngdp	0.749
	dlngdp→ dlnother	1.887
lngdp -lnresidential	dlnresidential →dlngdp	0.517
	dlngdp→ dlnresidential	0.007
lngdp -lnindustry	dlnindustry →dlngdp	1.518
	dlngdp→ dlnindustry	10.306
lngdp -lntotal	dlntotal →dlngdp	0.861
	dlngdp→ dlntotal	0.025

5. EVALUATION OF FINDINGS

As a result of the analysis made in the study, seven MENA countries, including high-income Bahrain, United Arab Emirates, Israel, Qatar, Kuwait, Oman, and Saudi Arabia, were accepted as suitable for homogeneous panel analysis. No causal relationship was found between electricity consumption and growth in public and commercial services, residential electricity consumption and growth, electricity consumption and growth in other sectors (agriculture, transportation), and total electricity consumption and growth in the seven countries in the MENA group. According to the panel Granger test, only a unidirectional causality relationship is found from economic growth to industrial electricity consumption. As economic growth increases in the related countries, industrial electricity consumption also increases. No causality relationship was found between other variables.

When the economic structures of the selected countries are considered in general, it is seen they are rich in natural resources (except Israel). Most of the GDP of these countries, which derive the majority of their GDP from natural resource exports, is based on exports. These countries, which earn a significant income thanks to the export of natural resources, meet their domestic consumption goods demand mostly through imports. The most important reason why there is no causality relationship between energy consumption and GDP in the 7 MENA countries included in the analysis is that the GDP mainly consists of natural resource export revenues. On the other hand, although Israel is not a country rich in natural resources, the reason why it exhibits homogeneity with other resource-rich countries can be shown as the fact that its GDP mostly has export revenues based on high technology and high value-added products that require low input in terms of energy consumption . We can say that the most important reason why the results in the general literature are completely different by analyzing the causality relationship between electricity consumption and GDP.

On the other hand, there were no results compatible with the studies of Hamdi, Sbia and Shahbaz (2014), Kayıkçı and Bildirici (2015), Saidi, Shahbaz and Akhtar (2018), Abdouli and Hammami (2017), Baydoun and Aga (2021) , Agboola, Bekun and Joshua (2021a), Saidi, Montasser and Doytch (2022) in the MENA countries, they expressed that there is a causal relationship between energy consumption and growth. It is thought that the reason for not obtaining concordant results is the time interval and method variation.

6. CONCLUSION

From the beginning of human history to the present, energy use has always been one of the keystones for human sustainability and development. Using human and animal power, this adventure continued with technology development through energy generation from water, wind, wood, and coal. The increase in demand for energy with the Industrial Revolution has also led to the diversification of energy sources. The discovery, spread, and more preferred of electrical energy along with evolving technology is also the aftermath of the Industrial Revolution.

This study examined the causality relationship between electricity consumed on a sectoral basis and GDP is observed to produce different results. Some studies have observed a one-way causality relationship between energy consumption to economic growth or energy consumption from economic growth. In contrast, some studies show a two-way causality relationship, and others show no causality relationship. On the other hand, different studies in the same country also show different results. The reason for this may be that the time interval examined, the analysis methods used or the variables are different.

In this study, the effect of industrial electricity consumption on growth was studied; Bahrain, United Arab Emirates, Israel, Qatar, and Kuwait in the MENA region, Public and service sector electricity consumption, domestic electricity consumption, other sectors' electricity consumption (transportation, agriculture) and total electricity consumption and GDP data were used in the seven countries where Oman and Saudi Arabia were located between 1990-2019. Natural localities of the series have been taken to ensure stagnation in the variant during the study's first phase. When the series was examined individually, it was observed that they did not have a specific trend, although they had a common sense of patience. Cross-unit heterogeneity and correlation testing have been performed. After these analyses, Westerlund (2007) conducted test statistics, which consider the inter-unit collection, and whether or not interchangeability is present. This analysis has not observed any uniformity between variables. The appropriate delay length and information criteria have been researched to determine which Panel VAR method to use for short-term causality analysis. Panel Granger causality test reveals a unidirectional causality relationship from GDP to industrial electricity consumption, while no causality relationship is found among other variables.

The basic hypothesis of this paper is “there is a positive relationship between electricity consumption and GDP growth in seven MENA countries.”. However, as a result of the analysis conducted with the Panel Granger causality test, it was concluded that there is only a unidirectional causality relationship between the economic growth and energy consumption variables of the relevant countries towards industrial electricity consumption, but there is no causality relationship between the other variables and the main hypothesis of the study was partially rejected. The main reason for this is that a large part of the GDP of the analyzed countries is derived from natural resource exports. It is known that unlike other countries in the analysis, a significant portion of Israel's GDP is derived from high-value-added technology products. When these countries included in the analysis are considered as a whole, it is seen that the incomes affecting the GDP growth are not very much dependent on energy consumption. When we look at the literature, it is seen that the countries with a relationship between energy consumption and growth are mostly production-based countries with intense energy consumption.

When the Israeli economy is analyzed, it is seen that it is a country that imports raw materials. An important source of income is obtained by processing the imported raw materials in the country and transforming them into high value-added products and exporting them. It is seen that 30% of the country's exports in 2021 consisted of high-tech product exports. At the same time, when the countries rich in natural resources are analyzed, it is seen that the income from natural resources in GDP is 17.6% in the United Arab Emirates, 8.7% in Bahrain, 16,6% in Qatar, 27,3% in Kuwait, 29.3% in Saudi Arabia, and 25,6% in Oman. It can be said that the energy spent for production increase in both industries, which have an important place in the income items of these countries, is low compared to the benefits provided.

In the studies carried out to date, it is seen that analyzes are made according to the period, geographical region, individual country analyzes, multi-country analysis, and country groups such as MENA and OECD. In the studies in the literature, it is seen that the factors that constitute the important income sources of the countries' GDP are ignored. With this study, it has been revealed that the differentiation of the elements that make up the GDP may show significant differences in the relationship between energy consumption and growth. These results made the study an important contribution to the literature.

The study does not necessitate Ethics Committee permission.

The study has been crafted in adherence to the principles of research and publication ethics.

The authors declare that there exists no financial conflict of interest involving any institution, organization, or individual(s) associated with the article. Furthermore, there are no conflicts of interest among the authors themselves.

The authors contributed equally to the entire process of the research.

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