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# Assessing the Intensity of Economic Progress, Industrialization, Energy Use on Environmental Degradation

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## ABSTRACT

This study intensifies the interrelationship between environmental downfall, economic and industrial enhancement, renewable and non-renewable energy consumption in the period of 1997 to 2018 for the G-7 and selected five MENA countries. The paper intends to explore how renewable energy, fossil fuel, electricity generation, GDP, and industrialization affect environmental pollution. For a dynamic panel data analysis, some statistical methods have been utilized, including Slope Homogeneity (SH), Cross Section Dependence (CSD), Cross-Section Im-Pesaran-Shin (CIPS), and Cross-Section Augmented Dickey-Fuller (CADF) of the second generation unit root tests, and the second generation (Westerlund-2007) CO-integration test, both Feasible Generalized Least Squares (FGLS), Panel-Corrected Standard Error (PCSE), and dynamic generalized method of moments (d-GMM) panel estimation approach have been applied. Feasible generalized least square (FGLS) shows that if GDP, fossil fuel energy consumption, industrialization, and electricity generation, increase by 1% then CO2 emission increases by 79.8%, 5.3%, 10.37%, and 8.26% respectively. If renewable energy increases by 1% CO2 emission decreases by 6.56%. When GDP growth rises, there is a corresponding increase in environmental pollution within industrialized economies. This demonstrates a positive correlation between GDP, industrialization, and CO2 emissions, which means that as the economy grows, environmental degradation will continue to worsen over time. Therefore, concerned parties should take proper policy steps to protect environment in industries and towards sustainable growth.

**Keywords:** CO2 emission; Renewable Energy; Fossil Fuel; Industrialization; Electricity generation



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## INTRODUCTION

The economic configuration is considerably influenced by industrialization, fossil fuel consumption, electricity generation, and the adoption of renewable energy. However, industrialization creates hindrances to achieving sustainable development. Climate change and its environmental pollution consequences have become a topic of contention. CO2 emission leads to an escalation in the adverse impacts of climate change. As the increase in CO2 emissions, the impact of climate change will fall out more visual due to the increase in temperature. The COP26 conference in 2021 aimed to restrict the rise in the average global temperature to 1.5 C higher than the levels before the industrial era (Dwivedi et al., 2022). Actually we want to show the environmental pollution impact of two regions, one is G-7 (Group of seven) those countries are Canada, France, Germany, Italy, Japan, United Kingdom, United States, are Economic superstar countries all over the world. That is based on trade, agreements, cultural exchanges, and other elements. These countries are also major economic players on the international stage and have developing economies.

Another is MENA (Middle east and North Africa) from selected five countries are (Egypt and Morocco is the North African country and the Israel, Saudi Arabia, United Arab Emirates are the middle east countries). The growth pattern of MENA countries is believed to be closely connected to various factors, such as their heavy dependence on oil, fragile economic base, fast population expansion, limited profitability of investing in physical and human capital, and limited level of worldwide incorporation (Makdisi et al., 2006).

According to The World health organization (WHO), every year 8.8 m people die worldwide from air pollution, 270,000 deaths in MENA and 238,000 people deaths in Europe (WHO, 2020). Numerous gases such as carbon dioxide (CO2), Carbon Monoxide (CO), chlorofluorocarbon (CFC), sulfur dioxide (SFO2), nitrogen dioxide (NO2), and Nitrogen oxide (NO) are accountable for atmospheric pollution. Co2 emissions are linked to processes (industrial or transportation) consuming fossil fuels like coal. Measuring Co2 emissions may be impossible. MENA is the Middle East/North Africa, population 300 million, diverse economies with oil-rich Gulf and resource-scarce countries (Goel et al., 2013).

The G-7 nations hold over 60% of the global total wealth and approximately half of its gross domestic product (GDP) comprising the United States (US), France (FR), Canada (CA), The United Kingdom (UK), Japan (JPN), Italy (ITA), Germany (DE) (Li & Haneklaus, 2022).



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The origins of this wealth can be traced back to the increase in industrialization and technological progress. Sustained economic growth relies on industrialization, but this has raised some environmental and economic policy considerations (Qin et al., 2021). Over the past twenty years, nations globally, pre-eminently developed ones have made notable progress in technology, advancement, and enhancing their human resources to achieve sustainable economic expansion. However, the rise of industrialization, technological improvements, and economic development has to pretend grave issues to the planet, resulting in climate alteration and worldwide warming (Eregha et al., 2022).

According to a 2008 report from the World Bank, the MENA (Middle East & North Africa) region is following not feasible path of development, as they channel their earnings from exporting crude oil towards oil extraction instead for utilizing these funds for sustainable economic progress. The report highlights a rise in Carbon dioxide ($CO_2$) emissions and a decline in per capita water resources in the area. As a result, recent empirical research has been examining the energy and ecological concerns in MENA countries (Bank, 2008). Studying the connection between energy usage, $CO_2$ emissions, Industrialization, and urbanization is significant as it can help us determine if industrialization and urbanization are contributors to the surge in energy consumption and $CO_2$ emissions in MENA countries (Al-Mulali et al., 2013).

In this study, we tried to examine to increase the GDP in terms of ($CO_2$) carbon emissions increase or decrease. And another impact of Fossil fuel, industrialization, renewable energy consumption, and Electricity generation is the actual impact on the environment using the G-7 and selected Five MENA countries by dynamic panel-data analysis using Feasible Generalized least square (FGLS), and Panel corrected standard Error (PCSE) and one step generalized methods of moments (GMM) from 1997 to 2018. Here $CO_2$ emissions are focused on a measure of air as environmental pollution. The objectives of this present study are:

a) To estimate the relationship between $CO_2$ emissions and positive growth of GDP impact on the environment of G-7 and Five MENA countries.
b) To analyze the $CO_2$ emissions controlled by improving renewable energy consumption and Industrialization.
c) To explore the electricity generation from Oil Gas and Coal impact on the Environment of G-7 and MENA countries.



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Therefore, the research is a novel one in the field of environmental economics as it has new contribution like introducing new variables impact on environment of selected countries with new technique and data set. The following part of the paper is organized with a brief analysis of previous studies related to the topics, a well-organized data formulation section, outcomes of the applied econometrical techniques and a brief summary speech with policy recommendation.

## LITERATURE REVIEW

Several empirical studies have focused on CO2 emission due to Renewable energy consumption and economic growth. Few studies included institutional quality in explaining CO2 emissions, and several studies checked the EKC hypothesis. Others have focused on exploring the connection between financial expansion and environmental condition.

Following the attempt by Osobajo et al. (2020), the authors analyzed 70 countries between 1994 to 2013 to examine the association between GDP growth, energy consumption and carbon dioxide emissions. The outcome from the granger causality tests indicate that unlike the explanatory variables such as population, capital stock, and GDP growth, there is a two-way causal relationship with Carbon emissions. The impact of energy consumption and economic growth on the environment was observed through OLS and polled OLS models. The co-integration test results also demonstrated a durable relationship among the variables.

Yilanci & Pata (2022) estimated how fiscal policy and economic growth impact CO2 emissions in G-7 countries over a long time series from 1875 to 2016. They explored the validity of the environmental Kuznets curve (EKC) hypothesis and assessed whether a fiscal policy has an impact on the environment. The results revealed that the causality from government expenditures to CO2 emissions varied over time, while the causality from economic growth to CO2 emissions remained consistent and did not change over time in all countries, except for major variations. Besides, Al-Mulali et al. (2013) investigated how urbanization, energy consumption, and CO2 emissions are interrelated in MENA countries from 1980 to 2009. Using a panel model, the study found that urbanization, energy consumption, and CO2 emissions were co-integrated. However, the strength of this relationship varied across countries, depending on their level of income and development. Additionally, Granger causality tests revealed both long and short-run bidirectional causal relationship between the variables. It is crucial for urban planners and policymakers in



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MENA countries to decelerate the rapid pace of urbanization to reduce pollution and energy consumption.

Moreover, Gorus & Aydin (2019) examined the causal links between energy usage, economic development, and CO2 emissions in eight oil-rich MENA countries from 1975-2014, using both single multi-country Granger causality analysis in the frequency domain. They concluded that energy conservation policies have no negative impact on Economic growth in the short- and medium-term but have negative effects in the long run.

However, Bildirici & Gökmenoğlu (2017) analyzed the interconnection between environmental pollution, economic advancement, and hydropower energy usage during divers' business cycle stages in G-7 nations spanning from 1961-2013. Markov switching – Vector autoregressive (MS-VAR) and MS-Granger causality approaches were utilized to accomplish this objective. The findings indicated that in the crisis and high-growth periods, carbon dioxide emissions and economic growth have Two-way causal relationship, whereas in general carbon dioxide emissions are the causal factor for economic growth. According to Wang et al. (2022), renewable energy contributes to limiting environmental contamination in both long and short-run relationship between energy consumption, economic growth, and the environment in the G-7 nations.

Solarin (2020) investigated the factors that conclude the environmental damage in 35 developing and emerging countries. With a particular emphasis on the impact of Fossil fuels, is the cause of climate change. The research employs and the ecological footprint as a measure of ecological degradation according to (GMM) Generalized Method of Moments, the outcomes reveal that the rise in subsidies for 10% of Fossil fuel in an increase in ecological footprint at.0% to 1.5% additionally. So the results indicate real GDP per capita, urbanization, can also amplify the Environmental degradation. Acheampong (2018) found that energy consumption harms carbon emissions. Appiah et al. (2021) investigated last two decades; there has been a significant rise in Global Carbon dioxide emissions. By utilizing the AMG, CCEMG, and DCCEMG estimation techniques, they revealed that energy consumption, industrialization, urbanization, and fossil fuel usage have an insignificant impact positive impact on CO2 emissions, except for energy consumption.

Moreover, Farhani et al. (2013) analyzed the 11 MENA countries during 1980-2009, and the results relevant to the environmental Kuznets curve (EKC). They incorporated some policy



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implications such as: 1) Energy use, GDP, and trade openness cause CO2 emissions; 2) Urbanization is a function that improves results, and positively affects pollution; 3) MENA seeks policy stabilizing GDP, trade, and control of energy increases.

To our best knowledge, there is no research has been conducted on the combined effects of renewable energy use, CO2 emissions, industrial development, fossil fuel consumption, and electricity generation on the G-7 and selected MENA countries. There has been individual conducting numerous studies on these areas, but they have not consolidated research collectively.

## METHODOLOGY

### *3.1 List of variables*

CO2 emission: It represents the total value of carbon emission expressed in kilo tons. In our study, we are using the logarithmic value of carbon emission as the explained variable.

GDP measures the market value of all final goods and services produced within a country's territory during a specific period (usually in a fiscal year). GDP memories the overall economic condition. As GDP increases, economic activities also increase which, in turn, increases the level of CO2 emission. That is why we selected GDP as an explanatory variable for our analysis.

Industrialization means the improvement of the industries of a state. In our study, we are using the industry including construction, (value added % of GDP) since with the process of industrialization CO2 emission happened to increase.

Renewable Energy consumption: Generated from natural sources, expressed Renewable Energy consumption has an associative relation with CO2 emission, and for that, it too is included in the model as an explanatory variable.

Fossil Fuel Energy Consumption: Energy consumed from fossil fuel tends to increase the emission of CO2 and so is included as an independent variable in the model.

Electricity production from Oil Gas and Coal: Electricity, nowadays, has become a driving force of the economy. The generation of electricity from Oil, Gas, and Coal has an additive


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impact on the amount of emission of CO2. This, thus, is embodied in the model as a control variable. Tables 1 and 2, hereafter, parade the variable list and summary statistics, respectively.

**Table 1:** *Variables statistics*

| Variable Name | Log Form | Indicators Name |
|---|---|---|
| CO2 Emission | L (CO2) | CO2 emissions (kt) |
| GDP | L (GDP) | GDP (constant 2015 US$) |
| Industrialization(including construction) | L (Ind) | Industry (including construction), value added (% of GDP) |
| Renewable Energy Consumption | L (RenEne) | Renewable energy consumption (% of total final energy consumption) |
| Fossil Fuel Energy Consumption | L (fossilfuel) | Fossil fuel energy consumption (% of total) |
| Electricity production from oil, gas and coal | L (EleOGC) | Electricity production from oil, gas and coal sources (% of total) |

For our study, data and each indicator were collected from the World Development Indicator (WDI) database which is patronized by World Bank. The fundamental major idea of this essay is also prospected in these tables. For proper review and analysis, we have provided descriptive data and a detailed list of criteria abreast.

**Table 2:** *Descriptive Statistics*

| Variable | N | Mean | Sta. Dev. | Min | Max |
|---|---|---|---|---|---|
| CO2 | 264 | 829474.6 | 1415295 | 29900 | 5775810 |
| GDP | 264 | 2.72e+12 | 4.22e+12 | 4.38e+10 | 1.95e+13 |
| Ind | 264 | 29.32705 | 11.65032 | 17.188 | 66.757 |
| RenEne | 264 | 7.944655 | 6.423238 | 0.009 | 23 |
| fossilfuel | 264 | 85.4379 | 13.20282 | 42.975 | 101.464 |
| EleOGC | 264 | 68.75721 | 27.2546 | 4.825 | 100 |

Table 2 summarizes variables in our study, including Mean, Maximum, and Average values of selected variables (G-7 and MENA countries) and an identical data set. Explained variable (CO2) has a Mean of 829474.6, SD 1415295, and a Maximum/Minimum of 5775810/29900 from 1997 to 2018. Explanatory variable (GDP) ham Mean 2.72e+12, SD 4.22e+12, and



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Maximum/Minimum 1.95e=13/4.38e+10. Other control variables are Industrialization, Renewable Energy, Fossil fuel, and Electrify production from Oil Gas and Coal with Mean 29.32705, 7.944665, 85.4379, and 68.75721 and Maximum/Minimum (66.757/17.188) for industrialization, (23/0.009) for renewable energy, (101.464/42.975) for fossil fuel and (100/4.825) for electricity production from Oil/Gas/Coal respectively.

### *3.2 Background and Model Specification*

CO2 emissions are considered to be the driving force of global climate alteration. To walk off the worst impact of climate change, we need to down curve the amount of CO2 emission. For this, we need to personify the determinants, as well as their direction and magnitude, of CO2 emission. The countries that make up the G7 (Group of Seven), studied in this research, have close ties among themselves that are based on trade, agreements, cultural exchanges, and other elements. These countries are also major economic players on the international stage and have developing economies. Most of the MENA country's characteristics, including their high reliance on oil, weak economic foundation, rapid population growth, low rates of return on investment in physical and human capital, and low level of global integration, are thought to be inextricably linked to the growth pattern of the MENA countries (Makdisi et al., 2006).

Although the G7 nations and the selected MENA countries are all economic superstars, the size of the indexes varies. (Hussain et al., 2022). As mentioned above, we identified some of the determinants which we now placed in an econometric model. First of all, our research is based on a sample of some selected economies which are Cross-sectional interdependent. Additionally, since there is more T than N, we are utilizing panel Co integration analysis in this investigation. Here, we make use of cross-sections from twelve various nations and for 22 years' time being. We are guided to prosecute traditional techniques like fixed and random effect models when N > T; but if T > N, we are unable to use them the countries that make up the G7 (Group of Seven), studied in this research, have close ties among themselves that are based on trade, agreements, cultural exchanges, and other elements. These countries are also major economic players on the international stage and have developing economies.

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G7 nations and the selected MENA countries are all economic superstars, the size of the indexes varies. (Hussain et al., 2020).

For the function of illustration purpose, the dependent variable in the preceding equation (1) is (CO2) Carbon Emission, and the independent variables are Gross Domestic Product (GDP), Industrialization (Ind), Renewable Energy (RenE), Fossil Fuel (Fossil), and Electricity production from Oil, Gas, and Coal (ElOGC).

$$CO_2 = f(GDP, IND, RenE, Fossil, ElOGC) \quad (1)$$

The relationship is shown in the figure 1.

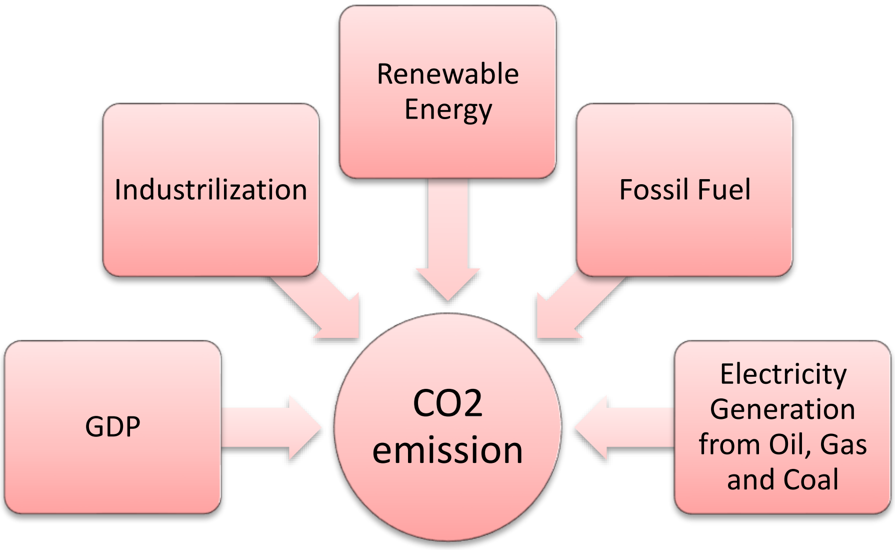


***Figure 1:*** Impact of selected explanatory variables on CO2 emission.
Source: Writer's formation

All variables in equation (2) are in log form (LCO2), which represents carbon emissions. Carbon emissions are affected by the gross domestic product (LGDP), industrialization (LInd), use of renewable energy (LRenE), consumption of fossil fuels (LFossil), and the production of electricity from oil, gas, and coal (LElOGC), as well as a random error term (ε). the countries are (i) and the year is (t).

$$LCO_2 = \propto_{0+} \propto_1 LGDP_{it} + \propto_2 LInd_{\ it} + \propto_3 LRenE_{it} + \propto_4 LFossil_{it} + \propto_5 LEOGC_{it} + \epsilon_{\ it} \quad (2)$$

### *3.3 Econometric Tools*



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Econometrics tools that are used to find out the regression analysis of equation (2) are slope homogeneity test, cross section dependency test, unit root tests, cointegration test and FGLS test (fig 2).

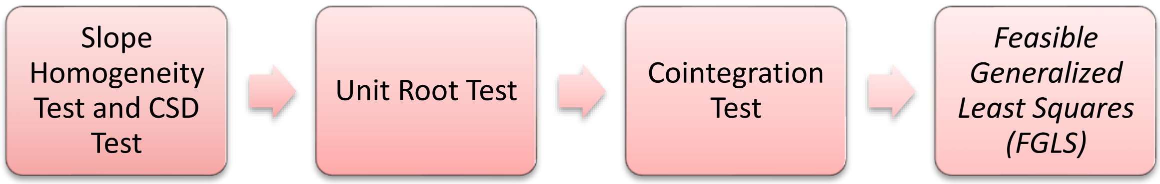


***Figure 2:*** Applied econometrics tools for the research.
Source: Writer's formation

3.3.1 Slope homogeneity Test

Heterogeneity in slopes is essential when using panel data with econometrics since the weights assigned to each country varies. The slope homogeneity test by (Pesaran and Yamagata 2008) as well as the CD test by Pesaran's analysis yields the existence of relationship between cross-sectional units and slope homogeneity amongst nations. (Sadorsky, 2009)

$$\Delta = \sqrt{N\left(\frac{N^{-1}\ S\% - K}{\sqrt{2K}}\right)} \qquad (3)$$

$$\Delta_{adj} = \sqrt{N\left(\frac{N^{-1}S\% - K}{\sqrt{\frac{2k(T-k-1)}{T+1}}}\right)} \qquad (4)$$

Slope Homogeneity test of Pesaran & Yamagata (2008) is determined by the distribution of the weighted slope within all countries. Above mentioned equation provides the Correspond to test statistics.

3.3.2 Cross section dependence test

It is estimated that while analyzing the panel data there will be no relation between variables studied in the model and coefficients, but if estimation does not work properly then it will show spurious result (Chudik & Pesaran, 2013). For that reason before entering into the


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estimation technique it is needed to check cross-sectional dependence among variables. Pesaran (2004) CD is mostly used cross-sectional dependence test which follows equation.

$$CSD = \sqrt{\frac{2T}{N(N-1)N}\left(\sum_{i=1}^{N-1}\sum_{k=i+1}^{1}\widehat{Corr}_{it}\right)} \quad (5)$$

3.3.3 Unit root test

Famous first-generation unit root tests developed by Harris and Tzavalis, ADF, Philips Perron, Breitung, Maddala, and Hadri; (Harris & Tzavalis, 1999), will not perform if CSD and SH problems are present so that we use the second generation unit root test CIPS and CADF equation represent in (6) and (7) (Westerlund & Hosseinkouchack, 2016).

$$CIPS = \frac{1}{N}\sum_{i=t}^{N} t_i(N,T) \quad (6)$$

The CADF (Cross –Augmented Dicky Fuller) test to use as follows the equation:

$$\Delta Yi_t = \varphi_i + \vartheta iYi_{t-1} + \delta i\bar{Y}_{t-1} + \sum_{j=1}^{p}\delta_{ij}\,\bar{Y}_{t-1} + \sum_{i=1}^{p}\beta_{ij}\Delta Y_{i,t-1} + \varepsilon_{it} \quad (7)$$

Here , $\bar{Y}_{t-1}$, and $\Delta Y_{i,t-1}$ are the average of the cross sectional analysis of lagged and first difference.

3.3.4 Co-integration Test

We used the Westerlund (2007) method to compute co integration in four panels. We use the second generation westerlund (2007) co integration test of these four equations respectively (Westerlund and Edgerton 2007).

$$G_{a} = \frac{1}{n}\sum_{i+1}^{N}\frac{\alpha'_i}{SE_{(\alpha'_i)}}$$

$$G_{t} = \frac{1}{n}\sum_{i=1}^{N}\frac{T\propto'_1}{\propto'(1)}$$

$$P_a = \mathrm{T}\alpha'$$

$$P_t = \frac{\alpha'}{SE(\alpha')}$$



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All slope coefficients are the same, serves as the null hypothesis for the test of slope heterogeneity. The results indicate that, the slope varies among nations and that the model's coefficients are not uniform.

3.3.5 Feasible Generalized Least Squares (FGLS)

FGLS is a statistical method used in panel data analysis to estimate the parameters of a linear regression model. It is a powerful tool that can help address several issues that arise in panel data analysis, such as heteroskedasticity and autocorrelation. Our investigation indicates the existence of cross-sectional interdependence and varying slopes (Alharthi & Hanif, 2020). To proceed with the study, we must use estimation methods suitable for panel data sets with a greater number of time series than cross-sectional units.

$$LCO_{2_{GLS}} = \propto + \beta_1 L_1 . lCO_{2_{it}} + \beta_2 lGDP_{it} + \beta_3 lInd_{it} + \beta_4 lReE_{it} + \beta_5 lFO_{it} + \beta_6 lElO_{it} \quad (8)$$

Equation 8 represents the GLS estimation method. Here, LCO2= as dependent variable (a vector of ‘n’ observation); $\propto$=is a metrics of independent variable (n.k); $\beta$=is a vector of coefficients to be estimated (k.1)

## RESULTS AND DISCUSSION

Any econometric analysis of panel data must begin with a cross-sectional dependence test. The results of Pesaran (2015) CSD test for weak cross-sectional dependence are tabulated below. It illustrates how cross-sectional dependence can affect panel data (Mercan and Karakaya, 2015). Most of the variable are rejected the Null hypothesis of this study and only one variable accepts the Null hypothesis. So that the variables LGDP, LGDP, LRenE, lFossilefuel, LElOGC are cross sectional dependent but LCO2 is cross sectional independent.

Most of the variables rejected the Null hypothesis of this study and only one variable is accepted the Null hypothesis. So that the variables LCO2, LGDP, LRenE, lFossilefuel, LElOGC, are cross sectional dependent but LCO2 is cross sectional independent (see in Table 3). After checking the cross sectional dependence among variables we will proceed to our studies by checking slope homogeneity of the coefficients prepared by (Pesaran & Yamagata, 2008). The outcome represents in Table 4 proves that null hypothesis no heterogeneity is rejected at 1% significance level. In this slope homogeneity test of Pesaran



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and Yamagata (2008), they developed the homogeneity test of Saw my and divided the model into Delta and Delta adjective. Table 4 shows the presence of heterogeneity in the model.

**Table 3:** *Cross-sectional dependency test*

| Variables | CD -test | p-value | mean ρ | Mean abs ρ |
|---|---|---|---|---|
| LCO2 | 1.00 | 0.315 | 0.026 | 0.692 |
| LGDP | 33.38 (***) | 0.000 | 0.876 | 0.876 |
| LInd | 10.32(***) | 0.000 | 0.271 | 0.512 |
| LRenE | 6.25 (***) | 0.000 | 0.164 | 0.712 |
| LFossil | 4.01 (***) | 0.000 | 0.105 | 0.706 |
| LElOGC | 12.81 (***) | 0.000 | 0.336 | 0.740 |

Note: Level of significance at 1%, 5%, 10% are denote the ***, **, and * respectively.

**Table 4:** *Slope homogeneity Test*

| Slope Homogeneity test statistics | | P value |
|---|---|---|
| $\Delta$ | 10.409(***) | 0.000 |
| $\Delta_{adj}$ | 12.605(***) | 0.000 |

Note: Level of significance at 1%, 5%, 10% are denote the ***, **, and * respectively.

We use the second generation unit root test to mitigate the cross sectional dependency when the panels are heterogeneous (Hurlin & Mignon, 2007). The next steps of this work is to use the second generation Panel Unit Root Test. Table 5 and 6 represents the CIPS and CADF (Pesaran 2007). According to the outcome of table 5, LCO2, LGDP, LElOGC shows stationarity at level with 1% significance level and LFossil shows stationary with 5% significance level. But rest two variables LInd and LRenE shows non stationary at level, in case of applying first difference they showed stationarity at 1% significance level. The result of CADF test tells that only LGDP and LInd show stationarity at level. Other variables such as LCO2, LRenE, LFossil and LElOGC show stationarity at first difference (see in Table 6).

**Table 5:** *CIPS (Unit root test)*

| Variable | Level | 1st Difference |
|---|---|---|
| LCO2 | -2.389*** | --- |
| LGDP | -2.337*** | --- |



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| | | |
|---|---|---|
| LInd | -2.000 | -4.248*** |
| LRenE | -1.745 | -3.663*** |
| LFossil | -2.207** | --- |
| LElOGC | -2.270*** | --- |

Note: Level of Significance 1%, 5% and 10% are describe by the sign of ***, **, and *, respectively

**Table 6:** *CADF (Unit root test)*

| Variable | Level | 1st Difference |
|---|---|---|
| LCO2 | -1.960 | -2.989*** |
| LGDP | -2.565*** | --- |
| LInd | -2.439*** | --- |
| LRenE | -1.911 | -2.794*** |
| LFossil | -1.992 | -3.098*** |
| LElOGC | -1.950 | -3.283*** |

Note: Level of Significance 1%, 5% and 10% are describe by the sign of ***, **, and*, respectively.

**Table 7:** *Westerlund test for cointegration*

| Variable | Value | Z value | P value |
|---|---|---|---|
| Gt | -2.650 | -1.538 | 0.062 (**) |
| Ga | -6.537 | 2.340 | 0.990 |
| Pt | -5.287 | 1.007 | 0.843 |
| Pa | -3.805 | 1.841 | 0.967 |

Note: the level of Significance 1%, 5% and 10% are describe by the sign of ***, **, and*, respectively

In general, error correction based co integration test of westerlund are applied when the model has the presence of cross sectional dependence and heterogeneity (Persyn & Westerlund, 2008). As our model shows cross sectional dependence and heterogeneity of coefficients, we are using Westerlund ECM co-integration test (see in Table 7). These outcomes are attained by using 1000 bootstrap reiteration. The acceptation of the null hypothesis of no co-integration states that 3 out of 4 variables are not co-integrated but the



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rest one rejects null hypothesis at 5% significance level is the indication of co-integration. According to Westerlund if any of Ga and Gt, the group mean statistics, shows co-integration it will mean that any one section from the panel is co-integrated but if any of the panel statistics, Pa and Pt, shows co-integration, it will indicate that the panel are co-integrated as a whole.

So, till now, our findings of this research are presence of cross-sectional dependence among variables, slope heterogeneity, and a co-integrated data set. At this stage of the study we need to follow an estimation technique. Following the study of Alharthi & Hanif (2020), a study can use Feasible Generalized least Square (FGLS) technique if the panel dataset has a more number of time series than number of cross section. As our dataset fulfill the prerequisites of performing FGLS, so we are performing FGLS in our study and table 8 contains the result of FGLS.

**Table 8:** *Feasible Generalized Least Squares Panel Estimation*

| Variable | Coefficient | St. Err. | P Value |
|---|---|---|---|
| LGDP | 0.7981915 | 0.0213224 | 0.000 |
| LInd | 0.1037224 | 0.0582287 | 0.075 |
| LRenE | -0.0656656 | 0.0142552 | 0.000 |
| LFossil | 0.5308889 | 0.1466879 | 0.000 |
| LElOGC | 0.0826512 | 0.0376685 | 0.028 |

Note: Level of Significance 1%, 5% and 10% are describe by the sign of ***, **, and*, respectively

The result of the Table 8 states that 1% increases in GDP, Carbon Emission will increase by 79.8%, If Industrialization increases 1% carbon Emission increases 10.37%, when renewable Energy consumption 1% increases 6.56% decreases in Carbon Emission. If Fossil fuel Energy Consumption 1% increases positive impact on The Environment at 5.3%. When Electricity production from Oil Gas and Coal increases at 1%, Co2 emission increases by 8.26%. And all of the variables show significant results. Renewable energy has a simple negative impact on the environmental coefficients are significant, but electricity generation is a positive impact on environment.

After getting the results of FGLS, to confirm more accuracy we perform Panel Corrected Standard Error (PCSE) which takes action against correlation (see in Table 9). The findings



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reveal that LGDP has a significant positive impact on carbon emissions, which indicate that for a 1% increase in GDP will increase carbon emission by 83%, LInd and LFossil also have a significant positive result which tells that 1 % increase in these variables will increase carbon emission by 54% and 169% respectively. LRenE has insignificant and ignorable positive results. LElOGC has a significant negative impact on carbon emission, 1% change in LElOGC will decrease the carbon emission by 25%. Electricity production from Oil Gas and Coal are adverse effect on the environment but DDP, renewable energy, industrialization and Fossil fuel energy consumption are the positive effect on environment.

**Table 9:** *Panels corrected standard errors (PCSEs)*

| Variable | Coefficient | Stn. Err. | P Value |
|---|---|---|---|
| LGDP | 0.837157 | 0.0211585 | 0.000 |
| LInd | 0.54039 | 0.1062081 | 0.000 |
| LRenE | 0.0003692 | 0.0140602 | 0.979 |
| LFossil | 1.694799 | 0.2337081 | 0.000 |
| LElOGC | -0.2562463 | 0.0643074 | 0.000 |

Note: the level of Significance 1%, 5% and 10% are described by the sign of ***, **, and*, respectively.

Now, focusing on the robustness check, we use two step system GMM method (see in Table 10). The results indicate that GDP, Industrialization, Fossil Fuel, Renewable Energy have a positive impact on carbon emission and Electricity production from Oil, Gas, and Coal has a negative impact. If 1% increases in GDP, carbon emission increase in 7.15%, 1 % increase in RenEne, IND, fossil fuel, increase the carbon emission by 0.4%, 8.63%, 13.25%; respectively. While 1% increase in Electrify Production from Oil, Gas, and Coal decreases carbon emission by 2.25%. So that when an increase in GDP our environmental pollution increases. Renewable energy consumption, Fossil fuel consumption and industrial improvement damage our environment positively.

**Table 10:** *GMM (Generalized Method of Moment)*

| Variable | Coefficients | St. Error | P value |
|---|---|---|---|
| LGDP | 0.0715664 | 0.0011249 | 0.000 |
| LInd | 0.0863649 | 0.006054 | 0.000 |
| lReneEne | 0.0046839 | 0.0008012 | 0.000 |



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| | | | |
|---|---|---|---|
| LFossil | 0.1325803 | 0.0181507 | 0.000 |
| LElOGC | -0.0225664 | 0.0042361 | 0.000 |

Note: Level of Significance 1%, 5% and 10% are described by the sign of ***, **, and*, respectively.

### *4.1 Justification*

As we know that, there is no research conducted on the combined effects of renewable energy use, CO2 emissions, industrial development, fossil fuel consumption, and electricity generation on the G-7 and selected MENA countries. While GDP, industrialization, and consumption of fossil fuels and renewable energy sources have favorable impacts on the environment, that means if those impact increases so that our environment more polluted in this region but the production of electricity from oil gas and coal as well as carbon emissions have negative consequences.

## CONCLUSIONS

This study analyzes the causal relationship among CO2 emissions, GDP, industrialization, fossil fuel consumption, renewable energy consumption, and Electricity generation impact on the environment through a panel data analysis of G-7 and selected MENA countries from 1997 through 2018. To verify the suggested, various statistical methods are utilized, including SH, CSD, CIPS of the second-generation unit root test, and the second generation (Westerlund-2007) co-integration test, both FGLS, PCSE, and dynamic GMM panel estimation approach is applied.

The study discovers that the GDP exhibits a positive expansion, leading to a global rise in carbon emissions and with the development of industry, environmental contamination worsened. However, the utilization of sustainable energy sources contributes to the deterioration of the environment. As a result, we recollect that in the era of globalization, humankind has become more modernized globally, but our surroundings are increasingly polluted. The production of electricity and the adoption of renewable energy sources have yielded mixed results, and the coefficients are significant for all G-7 and MENA countries. Besides, the consumption of Fossil fuels has to lead to an increase in carbon emissions.

## DECLARATION OF FUNDING



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The research has not been done with help of any funding from any source or organization.

## LIMITATIONS OF THE STUDY

The research has some limitations regarding not too much lengthy data span, few selected location and some econometric tools that might be used. However, these limitations arouse due to the unavailability of data and techniques. For future researchers this paper offers huge opportunities which may be solved.



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