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**Article**

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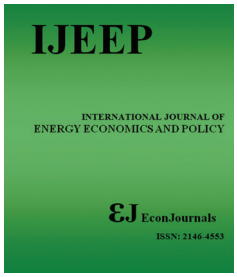

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# Development and Climate Change in OIC Countries: Examining Causality between Economic Development, Energy Consumption, and Emissions

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**ABSTRACT**

OIC countries experience a fast and stable socio-economic development over the last decades. However, in the same time environmental degradation have also escalated as a consequence of its development. A central question raises whether OIC countries can push socio-economic growth without reducing environmental quality, or whether this region can implement emission reduction strategies without impeding their growth potentials. In this regards, this study examines the econometric relationships between emissions and socio-economic including output, population, emission intensity, investment, and urbanization. Employing panel data from 49 OIC countries from 1990 to 2019, the results show that GDP per capita, population, emission intensity, value-added industries, and proportions of urban communities significantly affect per capita $CO_2$ emissions. It is suggested that climate change mitigation in emissions by OIC countries needs to be carried out both in the short and long term in reducing their dependence on fossil energy use both in production and consumption side, including the environmentally friendly technologies.

**Keywords:** OIC Countries, Development, $CO_2$ Emission
**JEL Classifications:** Q50, Q54, Q56, O11, O13

## 1. INTRODUCTION

OIC countries experience a fast and stable socio-economic development over the last decades. However, in the same time environmental degradation have also escalated as a consequence of such development. Even comparing with emerging economies, OIC countries are considered among main contributors of world $CO_2$ emissions. Unsustainable natural resource management, unstustainable industrial growth, unstustainable agricultural practices, and rising middle-income class consumption are attributed to this rising $CO_2$ emissions.

The increasing trend of $CO_2$ emissions generates debatable issues in OIC countries. A central question is whether OIC countries can push socio-economic growth without reducing environmental quality, or whether this region can implement emission reduction strategies without impeding their growth potentials. In this regard, this study examines the econometric relationships between emissions and socio-economic figures including output, energy intensity, investment and urbanization.

Previous studies investigated the relationship green house gas emissions and socio-economic development. These studies, mainly $CO_2$ emissions, ranged from cross or panel studies (e.g. Selden and Song, 1994; Coondoo and Dinda, 2002; Dinda and Coondoo, 2006; Baek et al., 2008; Bernard et al., 2011; Choi et al., 2010; Martínez-Zarzoso and Maroutti, 2011) to more specific regional or national studies (e.g. Akbostanci et al., 2009; Zhang and Cheng, 2009; Zaman, 2010; Tiwari, 2011; Nasir and Rehman, 2011). Apart from computation of $CO_2$ emissions, previous studies also

investigated the determinants of environmental degradation, for instance Shafik (1994), which differentiates them into structural and policy drivers, which are as follows: (1) endowment, e.g. location and climate; (2) income, which reflects the structure of production, private consumption, and urbanization; and (3) exogenous factors, particularly related to technology; and (4) respective policies, which reflects public decisions on the provisions of environmental public goods.

Specifically, the objectives of this study are as follows. First, we will do a descriptive and historical analysis of carbon dioxide gas emissions, economic growth and other control variables in OIC Countries. Second, we will examine the existence and direction between socio-economic growth, energy consumption and $CO_2$ emissions by employing panel data analysis. We further ask whether income, population, emission intensity, urbanization, industrialization and other possible control variables matter. Third, we will examine descriptive analysis and panel regression result to have a valid conclusions.

## 2. LITERATURE REVIEW

The effect of economic growth on environmental degradation has been widely discussed in journals. Arfanuzzaman (2016) mentions that there is a relationship between per capita income, the Human Development Index and the Environmental Index in Bangladesh. The results of this study indicate that economic growth will tend to reduce the quality of the environment which will eventually reduce the environmental performance index of Bangladesh. In addition, research on economic growth and the use of renewable energy consumption on the level of $CO_2$ emissions was also conducted in China, Dong et al, (2018). The estimation results in this study indicate that there is a positive relationship between economic growth and the level of carbon dioxide gas emissions, but the consumption of natural gas and renewable energy reduces the level of carbon dioxide gas emissions. This study recommends that China, which seeks to reduce $CO_2$ emissions, needs to substitute more environmentally friendly fuels for its production machines.

Environmental Kuznets Curve (EKC) hypothesis argues that severe environmental degradation is often found in developing countries, and the majority have low per capita income (see for instance Lau 2014). The EKC hypothesis explains that in countries with low per capita income, that many of them are found in pre-industrial or agrarian countries, will gradually adopt agricultural and other industrial mechanization so that resource use increases due to technology, so that pollution increases. In the long term, economic growth that results in environmental degradation also makes the country aware of expectations for life expectancy, cleaner water, improved air quality and cleaner habitats, so that environmental improvement is also a priority in economic development. Figure 1 shows the transition from pre-industrial countries to industrial economies and post-industrial economies will form a relationship in a curve that forms an inverted U between a country's per capita income and environmental degradation (Fodha and Zaghdoud 2015).

Research on the impact of urban population growth and energy consumption was conducted by Dash and Behera (2017) in South Asian and Southeast Asian countries using data from 17 countries. Using a data period of 1980-2012 and dividing countries into three sub-groups including high, middle, and low income by panel data analysis, the results of this study indicate that in the long term, energy consumption, FDI, urban population levels, and levels of $CO_2$ emissions have a positive and significant long-term relationship across all groups of countries.

## 3. DATA AND ESTIMATION STRATEGIES

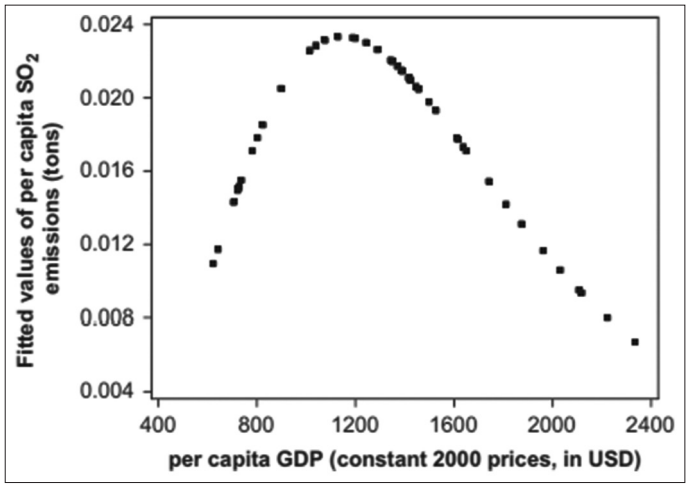
We use panel data of 49 OIC countries from 1990 to 2019 of $CO_2$ emissions (in metric ton per capita), real per capita GDP (in constant 2000 USD), $CO_2$ intensity (in kg), urban population (in percentage to total population), fossil energy consumption (in percentage to total energy consumption), and industry value added (in percentage to total value added). All data are taken from World Development Indicators (WDI) and Emission Database for Global Atmospheric Research (EDGAR).

To analyze the causality between $CO_2$ emissions, energy consumption and economic development, we employ a number of estimation techniques. First, we estimate a log linear specification to measure long-run causality between emission, energy consumption and output, which can be expressed as follows:

$$LNCO2CP_{it} = \alpha_0 + \alpha_1 LNGDPCAP_{it} + \alpha_2 LNPOP_{it} + \alpha_3 LNCO2INT_{it} + \alpha_4 P\_FOSSIL_{it} + \alpha_5 P\_URBAN_{it} + \alpha_6 P\_INDUSTRY_{it} + \varepsilon_{it}$$

where $LNCO2CP_{it}$ $LNGDPCAP_{it}$ $LNPOP_{it}$ $LNCO2INT_{it}$ refers to per capita $CO_2$ emissions, per capita output, population, and $CO_2$ Intensity (all in natural logarithm), P_FOSSIL, P_URBAN P_INDUSTRY represent percentage of fossil energy consumption to total energy consumption, percentage of urban population to total population, and percentage of industry value added to total value added, respectively. Finally, $\varepsilon_t$ represents the error terms assumed to be *i.i.d* $(0, \sigma^2)$.

**Figure 1:** Environmental Kuznets Curve




Source: Fodha and Zaghdoud (2015)

### 3.1. Development of Fossil Energy Consumption and Carbon Dioxide Emissions in OIC Countries

OIC countries are well-known as among the largest oil producers in the world. This has consequences for the consumption of fossil energy which is quite large even as the main energy source in economic activity. This is shown by a graph of the average percentage of fossil energy consumption to the total energy consumption of OIC countries.

Figure 2 shows the trend that since 1990, the average proportion of fossil energy use to total energy consumption in OIC countries tends to increase until 2019. The average proportion of fossil energy use is around 77–79% of total energy consumption in the country. From 1990 to 2019, it seems that the commitment of OIC Countries to use clean and environmentally friendly energy has not been seen. The proportion of the use of fossil energy as the main energy source for economic activities in OIC countries will certainly have a direct impact on the accumulation of carbon dioxide gas emissions released into the air and have an impact on accelerating global warming.

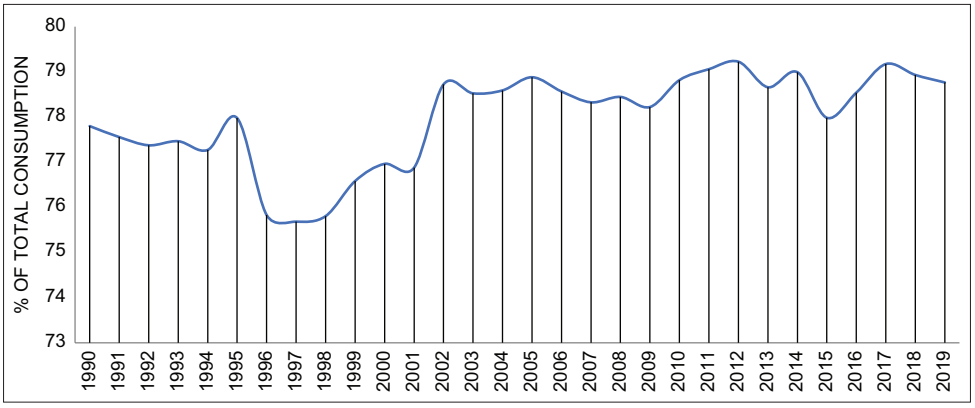
The use of fossil energy that tends to increase in the economic activities of OIC countries can also be seen as a consequence of industrialization in this region. In general, the development of industrialization in OIC countries, which is represented by the role of Industry in the Value Added of OIC countries, can be seen in Figure 3.

Figure 3 shows that the role of Industry in the economy of OIC countries is quite large in compiling the added value/GDP of OIC countries. The role of industry sector as an economic driver for OIC countries, which accounts for around 30% of value added/GDP from 1990 to 2019, is a major economic buffer in the economic activities of OIC countries. However, industrialization that occurs in OIC countries is directly proportional to the increase in the proportion of fossil energy use to the total energy consumption of OIC energy. This shows that the use of fossil energy is also used for industrial purposes in the production of goods/services. Increasing industrial and community activities in OIC countries that depend on the use of fossil energy, will have an impact on increasing $CO_2$ emissions.

The development of fossil energy as the main energy source can be seen from the development of carbon per capita $CO_2$ of OIC countries in the period 1990 to 2019 (Figure 4). It can be seen that average of per capita $CO_2$ emission of OIC countries tends to increase over time, as a consequence of increasing industrial and community activities as previously shown. Indeed it is argued that the trend of increasing average per capita $CO_2$ emissions from 1990 to 2019 is an unavoidable consequence of OIC countries due to their high dependence on fossil energy as the main energy source for all economic activities.

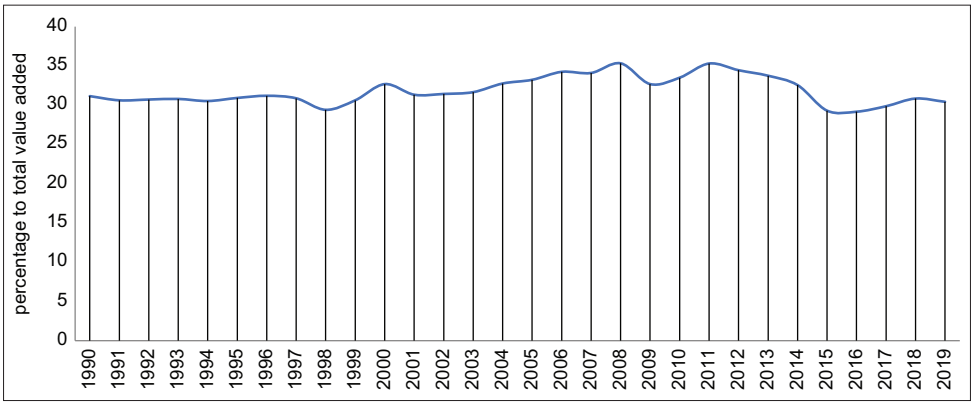
OIC countries which are dominated by developing countries will indeed worsen environmental quality degradation as a result of

**Figure 2:** Average fossil energy consumption (percentage of total Energy Consumption)




Source: The World Bank, World Development Indicators (2019)

**Figure 3:** Average of industry (including construction) value added to total value added




Source: The World Bank, World Development Indicators (2019)

economic activity, although it will greatly depend on geographical factors of an OIC country which is high in natural resources that are sensitive to climate and low adaptive capacity to the environment. Investigating OIC countries, existing climate models predict worsening of environmental and climatic conditions in this region which poses serious socio-economic consequences especially for the disadvantaged and poor populations (SESRIC, 2019). It is also reported that the majority of OIC member countries are characterised by poor environmental performance and a high level of vulnerability to temperature change (SESRIC 2019), as shown ini Figure 5. Qatar is that the best playing and most environmentally property country, followed by Turkmenistan, Balkan nations and Brunei Darussalam. On the other hand, twenty four OIC member countries are hierarchal among the formeost vulnerable and lowest performing countries within the world.

## 4. ESTIMATION RESULTS

The relationship between the use of fossil energy and other socio-economic variables on the level of carbon dioxide gas emissions is estimated by panel data regression analysis. To see the robustness of extimation techniques, we employ several panel data models including the Fixed Effect Model, Random Effect Model, Autoregressive Fixed Effect Model, and Autoregressive Random Effect Model to estimate the coefficient of the effect of fossil energy variables and other variables on carbon dioxide gas emissions per capita of OIC countries. The estimation results can be seen in Table 1.

Estimation results show that per capita GDP (LNGDPCAP) significantly and positively affects per capita $CO_2$ emissions in all models. The increase in the income of the people of OIC countries directly increases per capita $CO_2$ emissions. Per capita GDP with a positive sign indicates that economic activities that increase GDP per capita have a negative impact on the environment, i.e. the increase in per capita $CO_2$ emissions. In this regards, as a major oil-producing country, in order to drive industrial machines as the economic driving force, OIC countries need to pay attention to environmental impacts in line with the expansion of economic activity. This finding confirmed the Environmental Kuznet Curve hypothesis that suggests that increasing income (affluence) of low- and middle-income countries will respond positively to increased environmental degradation, whereas high-income countries will respond negatively to environmental degradation. OIC countries that are generally middle-income through this model are proven to support the Environmental Kuznet Curve hypothesis when an increase in GDP per capita will also increase environmental degradation.

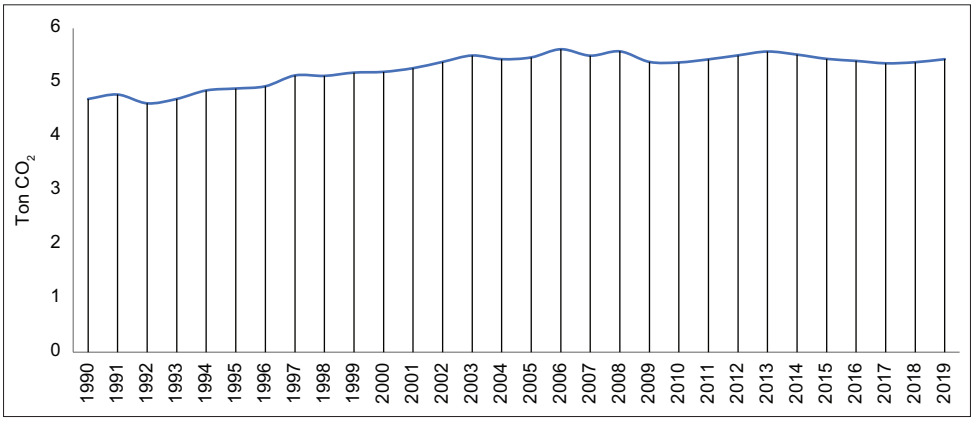
Population (LNPOP) has a positive and significant impact on per capita $CO_2$ emissions, i.e. the increase in the population tends

**Table 1: Estimation Results Dependent Variable: $LNCO2CP_{it}$**

| Variables | Fixed Effect Model | Random Effect Model | Autoregressive Fixed Effect Model | Autoregressive Random Effect Model |
|---|---|---|---|---|
| $LNGDPCAP_{it}$ | 0.488048*** | 0.2898457*** | 0.2233272*** | 0.14376658** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| $LNPOP_{it}$ | 0.099137*** | 0.0335425 | 0.1887202*** | 0.1649583*** |
| | (0.002) | (0.269) | (0.004) | (0.000) |
| $LNCO2INT_{it}$ | 0.116925*** | 0.1603105*** | 0.0750658*** | 0.0952762*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| P_FOSSIL | 0.001908* | 0.0030019** | 0.0026004*** | 0.0031423*** |
| | 0.096 | (0.011) | (0.001) | (0.000) |
| P_URBAN | 0.010114*** | 0.0203993*** | 0.0063447** | 0.01184*** |
| | (0.000) | (0.000) | (0.011) | (0.000) |
| P_INDUSTRY | 0.004430*** | 0.0074805*** | 0.0010521 | 0.0031832*** |
| | (0.001) | (0.000) | (0.236) | (0.001) |
| Hausmann Test | 250.16 | prob : 0.000 | | |
| N | 1519 | 1519 | 1519 | 1519 |
| Adjusted R-Sq | 0.3208 | 0.2917 | 0.0622 | 0.2725 |

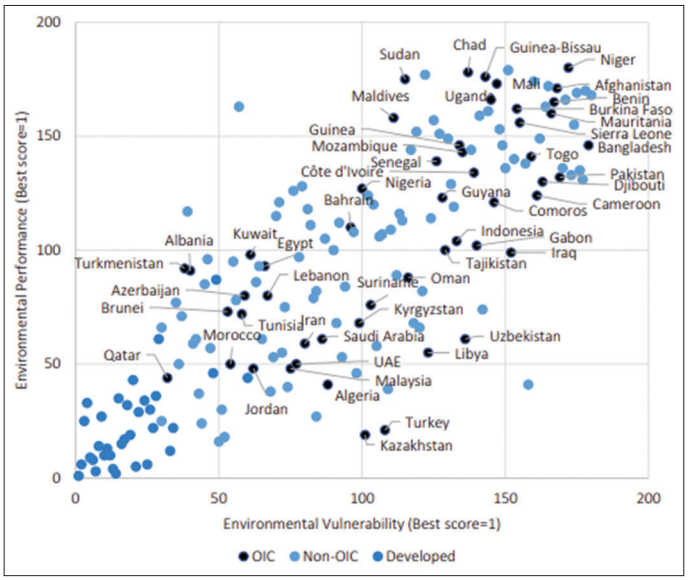
*Significant at 10%, **Significant at 5%, ***Significant at 1%, *P* value

**Figure 4:** Average of $CO_2$ emission per Capita of OIC Countries




Source: EDGAR (2019)

**Figure 5:** Environmental performance and environmental vulnerability of OIC, Non-OIC and developed countries




Source: adapted from SESRIC (2019)

increase per capita $CO_2$ emissions. This indicates that the increase in public consumption, especially in fossil energy, will increase carbon dioxide gas emissions. This is in line with the $CO_2$ Intensity variable which also has a positive and significant effect on the level of carbon dioxide gas emissions.

$CO_2$ Intensity, represented by LNCO2INT, has a positive impact on per capita $CO_2$ emissions. This means that the higher emission intensity contributes to pollution. In OIC countries, the intensity of $CO_2$ emissions from the use (production) of energy tend to increase the level of $CO_2$ emissions. This finding suggest that OIC countries still have structural challenges to decrease $CO_2$ intensities overtime in order to decrease the level of emissions. The OIC member countries need to implement a more carbon-efficient energy mix of their energy system.

Fossil fuels as the main energy source will increase per capita $CO_2$ emissions, as suggested by positive estimation of P_FOSSIL coefficient. As it was previously known that the average proportion of fossil energy use to total energy consumption is around 70%, this shows that OIC is very dependent on fossil energy to meet its main energy needs, but on the other hand it has an impact on increasing per capita $CO_2$ emissions and global warming.

The rate of urbanization, represented by P_URBAN, has a positive and significant impact on per capita $CO_2$ emissions in OIC countries. In addition to the problem of dependence on heavy-dependence on fossil energy which can increase carbon dioxide gas emissions, the rate of urbanization is also another factor that increases per capita $CO_2$ emissions of OIC countries. A possible explanation is that regional (rural-urban) inequality and the need for employment has led to a high rate of urbanization, resulting in a high level of economic activity in the city, especially production machines which have side effects on per capita $CO_2$ emissions in OIC regions.

Industrial activity, represented by the P_INDUSTRY, has a positive and significant impact on the level of carbon dioxide gas emissions in OIC countries. This shows that industrial activities in OIC countries, representing the production activities, are still very dependent on the use of energy that emits $CO_2$ emission. The OIC countries, which many of them are oil-producing countries, of course also directly use oil as fuel for production activities. This also means that OIC countries still have several challenges towards a more sustainable production activities.

## 5. CONCLUSION AND RECOMMENDATIONS

To date, energy sources of OIC countries are heavily dependent on fossil energy as the main energy source in driving economic activity. Industrial and community activities that depend on the use of fossil energy directly will increase the accumulation of $CO_2$ emissions. The increase in industrial activity that drives the economic growth of OIC countries has an impact on environmental degradation. $CO_2$ missions that accumulate in the air will certainly have an impact on global warming so that in the long term it will cause serious damage to the lives of living things and economic resources. In addition to the economic aspect, another control variable that also affects carbon dioxide gas emissions is the increasing number of urban population due to urbanization.

Climate change mitigation, particularly related to reducing $CO_2$ missions by OIC countries, needs to be carried out both in the short and long term. In this regards, OIC countries need to reduce their dependence on fossil energy as the main energy source in socio-economic activity. The use of environmentally friendly energy and products is more than an option that needs to be done in climate change mitigation. In production or industrial activity, the production technology needs to be more environmentally efficient. Apart from the use of renewable energy in production process, green technology adoption from developed countries to OIC countries, needs to be done to gradually replace "dirty" production process. More over, the imposition of a carbon tax (apart from gradual reduce in fossil fuel subsidy) can be another important ways to be realized as compensation for environmental degradation that occurs due to increased $CO_2$ emissions.

These actions need to be taken in an effort in climate change mitigations in the future. The continuous rate of GHG gases, mainly $CO_2$ emissions allowed by the OIC countries will have a serious impact on the environment and will require greater costs to improve the environment. Economic growth which is the goal of OIC countries also needs to calculate the impact of environmental damage and calculate compensation costs for environmental improvements due to expansion of economic activity in order to promote a green growth strategy. Finally, further researches on climate mitigation and adaptation for the case of OIC countries need to be carried in order to promote a more sustainable growth in this region.

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