Evaluating the Impact of Carbon Emissions on Iraq's Economic Growth

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Abstract: Environmental pandemonium is said to have emerged from global warming which influences water availability, sea levels, food production, and weather patterns. These are all caused by CO_2 emissions, which might have a large influence on economic growth. However, there is limited evidence about the link between CO_2 emanations and economic growth in Iraq. Thus, there is a need to empirically examine how CO2 emissions influence economic growth in Iraq. Therefore, this study applies the Environmental Kuznets Curvature perspective (EKC) to examine the influence of CO_2 emanations on economic growth in Iraq. Data was extracted from the World Bank for the period 1991 to 2020. 2gls regression model was used to account for possible endogeneity and reverse causality in the data set. The results from the analysis show that an increase in CO_2 emissions via manufacturing and construction and CO_2 emissions via agricultural methane increase GDP growth per capita. Consistent with the environmental Kuznets curve (EKC) theory, it was found that an increase in CO_2 emissions via gaseous fuel consumption, CO_2 emissions via liquid fuel consumptions, and CO_2 emissions *via* energy-related methane have an inverse link with GDP growth per capita. The findings of the study will be useful for law makers in implementing policies and strategies related to greenhouse gas emissions and economic expansion in Iraq.

Keywords: CO_2 emissions, Environmental pandemonium, Economic Growth.

1. INTRODUCTION

Climate transformation represents a long-term variation in temperature and weather patterns. Although this climate transformation could be due to natural happenings, but for the past few decades human-related activities have been the leading driver of ecological change, largely due to the sweltering of fossil fuels such as oil and gas and coal, which yields heat-trapping gases. These human-related activities are presumed to be the major causes of global warming. It has been argued that greenhouse gas emissions (GHG), notably carbon dioxide (CO2) emissions, are considered the primary driver of global warming (Soytas et al., 2007). Manufacturing process and combustion of fossil fuels both produce carbon dioxide emissions (CO2 emissions). They also comprise CO_2 produced while utilizing gas flaring and solid, liquid, and liquid fuels. These activities could have a direct influence on human welfare and economic growth. Therefore, the term "carbon emissions" is used to describe all GHG emissions, whether they are caused directly or indirectly by people, groups, organizations, or products. The impact of these emissions on the economic, social, and political levels is now widely acknowledged, as is the necessity of reducing greenhouse gas emissions to mitigate climate change (Akadiri et al., 2019). According to Climate Watch report 2020, Iraqi's CO_2 emanations- metric tons per capita have been on the increase since 2016. The trends reported by the Climate Watch report 2020, show that 1997 had the highest volume of 5.5 metric tons per capita with 2007 having the lowest volume of 2.7 metric tons per capita. Recently, there has been an increase from 2016, 2017, 2018, and 2019 with 3.9, 4.1, 4.2, and 4.4 metric tons per capita respectably.

In view of the above, there is a need to investigate how CO2 emissions influence economic growth in Iraq. This is due to the fact that CO2 emissions are crucial to environmental preservation and sustainable growth. Moreover, past studies have documented that an improved in economic growth is linked to an increase in CO_2 emissions. Furthermore, it is likely that cutting carbon emissions at the price of economic expansion, especially in developing countries, is not the optimal course of action or would not have the intended effects (Akadiri et al., 2019; Liu et al., 2022)**.** There is limited evidence about the link between CO_2 emissions and economic growth in Iraq. Therefore, despite the notable increase in CO_2

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emissions and the consumption of fossil fuels over time, to our knowledge, there are not many studies on the link between Iraq's economic growth and CO_2 emissions. Moreover, according to Energy Information Administration report 2021, Iraq is the world's 12th-largest energy carbon emitter in 2020. Therefore, this study applies the Environmental Kuznets Curvature perspective (EKC) to examine the effect of CO_2 emissions on economic growth in Iraq. The findings of the study will be useful for law makers in implementing policies and strategies related to greenhouse and gas emissions in Iraq.

2. LITERATURE REVIEW

This study examines the environmental Kuznets curve (EKC) theory, which holds that income growth and environmental degradation have an inverse U-shaped connection. In other words, in the initial phases of economic expansion, environmental degradation is correlated with per capita income; but, after a specific threshold is reached, it is inversely correlated with per capita income. This suggests that CO2 emissions could have both constructive and adverse consequences on economic development (Zhang & Cheng, 2009). Subsequently, a growing body of research has looked at the connection between CO2 emissions and economic expansion. The empirical results, however, appear to be contentious. Therefore, past studies have examined the influence of CO2 emissions on economic growth in different economies (Acaravci & Ozturk, 2010; Akadiri et al., 2019; Nikolaos et al., 2016; Ozturk & Acaravci, 2016). For instance, (Akadiri et al., 2019) studied the influence of energy use, carbon emissions, and economic growth in Iraq. They employed data from World Bank from 1972 to 2013. They showed CO2 emissions do not directly influence economic growth in Iraq. However, their study only focuses on the aggregate of CO2 emissions. Therefore, there need to examine different components of CO2 emissions from various sectors. This current study examines CO2 emissions from manufacturing industries, construction, gaseous fuel consumption, liquid fuel consumption, and agricultural methane emissions. Acaravci and Ozturk (2010)studied the connection between energy usage, greenhouse gas emissions, and European economic growth. They found that, in Denmark and Italy, respectively, carbon emissions have estimates of the long-run elasticity that are both positive and negative with regard to real GDP and the square of per capita real GDP, respectively. Zhang and Cheng (2009) conducted research on China's energy use, carbon emissions, and economic expansion. They demonstrated that rising economic growth is not caused by carbon emissions. Ozturk and Acaravci (2016) looked at energy use, CO2 emissions, and economic expansion in Cyprus and Malta. The researchers discovered a long-term connection between Malta's economic development and CO2 emissions. Koondhar et al. (2018) investigated how air pollution, energy use, and impacted economic growth in US and China. They found a connection between China's energy consumption and economic growth. This has been confirmed by Coondoo and Dinda (2008). Recently, Pala (2020) studied how climate change influenced the GDP of 28 EU countries. He demonstrated how rising carbon emissions help the relatively chilly countries of North and East Europe develop economically. Increased carbon emanations have a favorable influence on economic growth, particularly in North and East European regions through the agricultural and tourism sector outputs. More so, Shen et al. (2023) examined the influence CO_2 emissions, and economic expansion in China. They found that the degree of decoupling between economic growth and carbon emissions differs among economic areas. Alvarez and Monta˜n´es (2023) examined the effect of energy use, CO_2 emissions, and economic expansion. They showed that more work is required to develop more sustainable economies and more environmentally friendly energy sources. Asante and Gil-alana (2023) studied the relationship between CO2 emissions, energy use, and economic growth in Western and Central Africa. They found that the present value of economic growth is influenced by previous CO2 emission values.

In view of the above argument, the study hypothesised that;

H1 Co2 emissions via manufacturing and construction have influence on economic expansion in Iraq.

H2 Co2 emissions via machines and transport have an influence on economic expansion in Iraq.

H3 Co2 emissions via gaseous and Fuel Consumption have influence on economic expansion in Iraq.

H4 Co2 emissions via Agricultural Methane have influence on economic expansion in Iraq.

H5 Co2 emissions via Liquid Fuel Consumption have influence on economic expansion in Iraq.

H6 Co2 emissions via energy related methane have influence on economic expansion in Iraq.

3. METHODOLOGY

The study employs a quantitative research paradigm. The World Bank online database is the source of data for the years 1991 to 2020. Following Akadiri et al. (2019), the variables used are yearly percent GDP per capita growth and CO2 emissions in metric tons per capita. Consistent with the unit root test, though not tabulated, the variables are reported according to their level forms. Additionally, the availability of the data limits the time series choices. There are two potential connections between the two factors—economic expansion and carbon emissions.

4. RESULTS

4.1. Descriptive Information of Data

Table **1** depicts the descriptive statistics for the relevant variables. Fig. (1) depicts Fig. (1) GDP growth per capita time series graph, while Figs. (**1**, **2**, **3**, **4**, **5**, **6** and **7**) show the CO2 emissions via manufacturing and construction, machines and transport, gaseous and fuel consumption, agricultural methane, liquid fuel consumption and energy related methane time series graphs in metric tons per capita.

4.2. Model Specification

$$GDPGrowthPerCapita_t=\beta_0+\beta_1 Co2emisManufa\&Const_t+\beta_2 Co2emisMachines\&Transf_t$$

Table 1. Descriptive Information.

Variable	Obser.	Mean	Std. Dev.	Min	Max
GDP Growth Per Capita	30	14.673	2.361	-64.047	53.381
Co2emisManufa&Const	30	11.920	2.564	7.381	16.554
Co2emis Machines &Transf	30	4.622	3.790	-0.516	13.042
Co2emis Gasfluel Consump	30	6.329	4.112	1.2057	16.081
Co2emis Agric Methane	30	23.899	10.529	10.521	40.999
Co2emis Liqfuelconsump	30	58.387	15.311	36.902	82.165
Co2emienergyrelated Methane	30	52.303	31.664	5.475	83.156

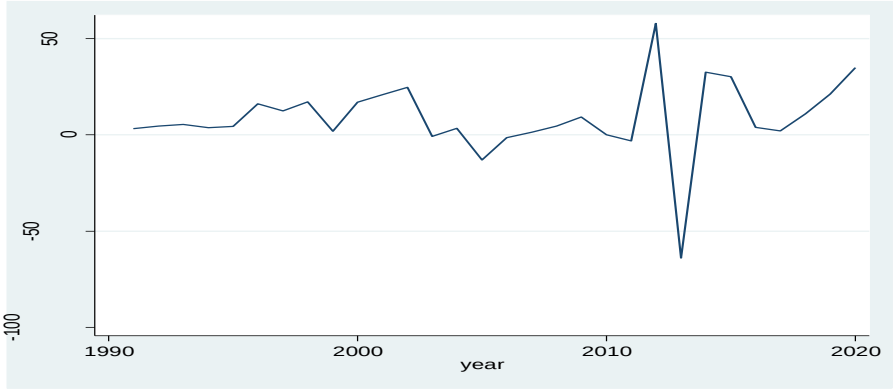

Fig. (1). GDP Growth Per Capita time series graph.

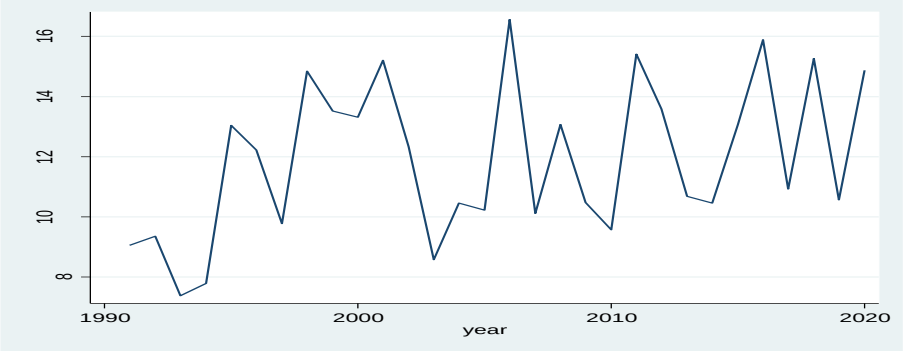

Fig. (2). CO2 emissions Manufacturing and Construction time series graph.

$+\beta_3 Co2emisGasfluelConsump_t+\beta_4 Co2emisAgricMethane_t+\beta_5 Co2emisLiqfuelconsump_t+\beta_6 Co2emisLiqfuelconsump_t+\acute{\varepsilon}_t$

Where, GDP Growth Per Capita = (GDP per capita rise expressed as an annual percentage), Co2emisManufa&Const = (Co2 emissions via Manufacturing and Construction), β_2Co2emisMachines&Transf = (Co2 emissions via Machines and Transport), Co2emisGasfluelConsump = (Co2 emissions via Gaseous and fuel utilisation), Co2 emis Agric-Methane **=** (Co2 emissions via Agricultural Methane), Co2 emis Liqfuelconsump = (Co2 emissions via liquid fuel utilisation), Co2emisLiqfuelconsump = (Co2 emissions via energy related methane)**,** $\acute{\varepsilon}$ = error terms, $\beta_0 - \beta_6$ = estimation Coefficients and t = time.

Fig. (**1**). depicts the economic graph that describes the trends and intercepts of GDP per capita rise expressed as an annual percentage.

Fig. (**2**) depicts the economic graph that describes the trends and intercepts of CO2 emissions via manufacturing and construction in metric tons per capita CO2emissions**.**

Fig. (**3**) depicts the economic graph that describes the trends and intercepts of CO2 emissions via machines and transport in metric tons per capita CO2emissions.

Fig. (**4**) depicts the economic graph that describes the trends and intercepts of CO2 emissions via gaseous and fuel consumption in metric tons per capita CO2 emissions**.**

Fig. (**5**) depicts the economic graph that describes the trends and intercepts of CO2 emissions via agricultural methane in metric tons per capita CO2 emissions**.**

Fig. (**6**) depicts the economic graph that describes the trends and intercepts of CO2 emissions via liquid fuel consumption in metric tons per capita· CO2 emissions**.**

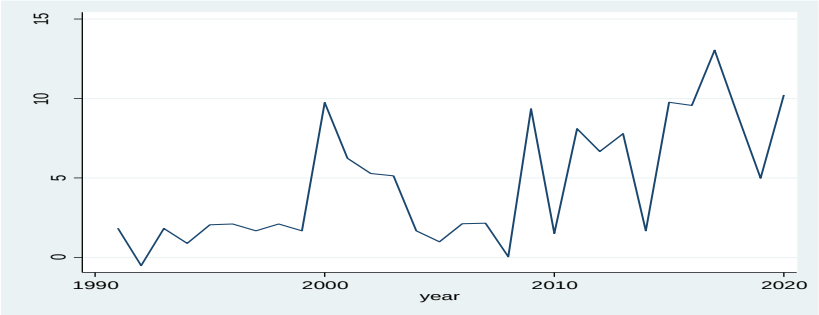

Fig. (3). CO2 emissions Machines & Transport time series graph.

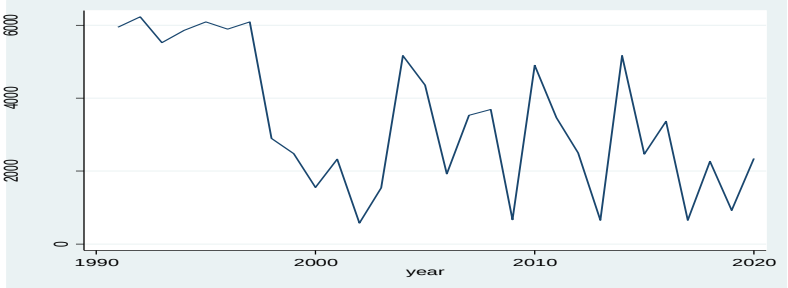

Fig. (4). CO2 emissions Gaseous & Fuel Consumption time series graph.

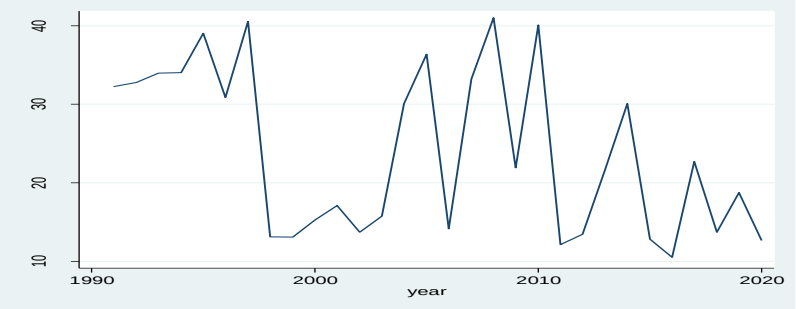

Fig. (5). CO2 emissions Agricultural Methane time series graph

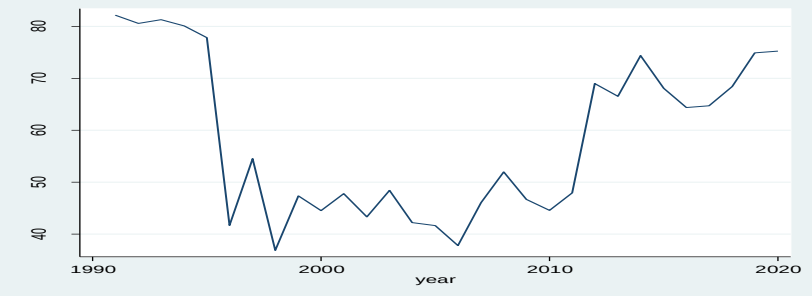

Fig. (6). CO2 emissions Liquid Fuel Consumption time series graph.

Fig. (**7**) depicts the economic graph that describes the trends and intercepts of Co2 emissions via energy related methane in metric tons per capita.Co2 emissions**.**

Table **2** depicts the correction results of the relevant variables. The Table shows that Co2 emissions via manufacturing and construction and machines and transport are positively connected with GDP rise per capita, While Co2 emissions via gaseous and fuel consumption, agricultural methane, liquid fuel consumption and energy related methane are negatively correlated with GDP growth per capita.

Table **3** depicts 2SLS regression. The study employs 2SLS regression because when endogeneity or reverse causality is present, OLS can result in inaccurate and inconsistent parameter estimates. Moreover, testing hypotheses can be very deceptive. Consistent with the past studies, there are two kinds of interrelationships between Co2 emissions and economic growth. The first connection hypothesizes growth as the likely source of carbon emanations, whereas the second relationship assumes carbon emanations as the cause of growth (Akadiri et al., 2019; Gessesse & He, 2020; Ozturk & Acaravci, 2016). Consequently, 2SLS regression can address

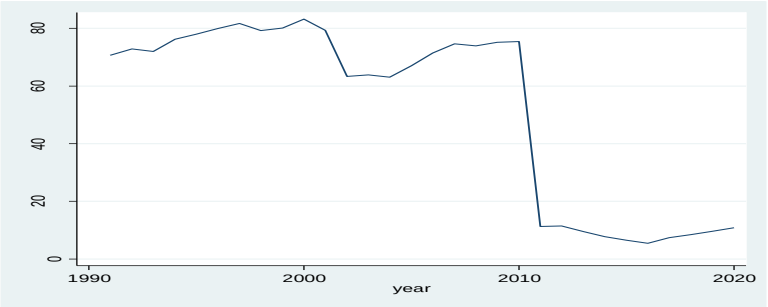

Fig. (7). CO2 emissions Energy related methane time series graph.

Table 2. Correlations.

GDP Growth Per Capita	**1**						
Co2emis Manufa & Const	0.421**	1					
Co2emis Machines & Transf	0.021						
Co2emisGasfluelConsump	0.627***	0.401**	1				
Co2emisAgricMethane	0.000	0.028					
Co2emisLiqfuelconsump	-0.653***	-0.373**	-0.698***	1			
Co2 emienergy related Methane	0.000	0.042	0.000				
GDP Growth Per Capita	-0.486***	-0.649***	-0.672***	0.727***	1		
Co2emis Manufa & Const	0.007	0.000	0.000	0.000			
Co2emis Machines & Transf	-0.139	-0.301	0.065	0.277	0.155	1	
Co2emis Gasfluel Consump	0.463	0.106	0.734	0.138	0.412		
Co2emis Agric Methane	-0.739***	-0.277	-0.638***	0.380**	0.477**	-0.415**	1
Co2emis Liqfuelconsump	0.000	0.139	0.000	0.038	0.008	0.023	

Table 3. 2SLS Regression.

Variable	**Coefficients.**	**Robust Std. Err.**	**Z-Stats**	**P-V**
Instrumented: GDP growth annual %	-0.140	0.068	-2.000**	0.045
Co2emisManufa & Const	0.179	0.087	2.070**	0.038
Co2emisMachines &Transf	-0.012	0.067	-0.180	0.858
Co2emis Gasfluel Consump	-0.001	0.000	-2.880**	0.004
Co2emis Agric Methane	0.092	0.038	2.400**	0.016
Co2emis Liqfuel consump	-0.058	0.021	-2.720***	0.006
Co2emienergyrelated Methane	-0.067	0.008	-8.060***	0.000
Cons	19.226	2.187	8.790***	0.000
Sample	1991 - 2020			
R^2	0.834			
obs	30			
Wald X^2	238.670			
Prob X^2	0.0000			

this type of interrelationships and control for endogeneity or reverse causality. The Table shows that Co2emis Manufa & Const and Co2emisAgricMethane have a positive significant link with GDP growth per capita. This implies that an increase in Co2 emissions via manufacturing and construction and Co2 emissions via agricultural methane increase GDP growth per capita, which in return enhances economic growth. This corroborates the argument by Ozturk and Acaravci (2016) who claimed that the connection between Co2 emissions and economic growth may be perceived in terms of production linkages, where carbon emissions could be considered as a required input in boosting economic development. This also supports the hypotheses one and four of the study which claim that Co2 emissions via manufacturing and construction and Co2 emissions via agricultural methane have influence on economic expansion in Iraq. Co2emis Machines & Transf has an inverse but insignificant link with GDP growth per capita. This indicates that Co2 emissions via machines and transport do not influence economic growth in Iraq. The finding also does not support the hypothesis three earlier mentioned which claimed that Co2 emissions via machines and transport have influence on economic expansion in Iraq.

The Table also indicates that Co2emisGasfluelConsump, Co2emisLiqfuelconsump, and Co2emienergyrelatedMethane have an inverse significant link with GDP Growth Per Capita. This infers that an increase in Co2 emanations via gaseous fuel utisation, Co2 emissions via liquid fuel utisation, and Co2 emissions via energy-related methane reduce GDP growth per capita. This confirms the environmental Kuznets curve (EKC) theory, which holds that income growth and environmental degradation have an inverse U-shaped connection. It infers that in the initial phases of economic expansion, environmental degradation is allied with per capita income; then, after a specific threshold is reached, it is inversely correlated with per capita income. This also supports the hypotheses three, five, and six of the study which stressed that Co2 emissions via gaseous fuel consumption, Co2 emissions via liquid fuel utisation, and Co2 emissions via energy related methane have influence on economic expansion in Iraq.

CONCLUSION

This study applies the Environmental Kuznets Curvature perspective (EKC) to examine the influence of CO2 emanations on economic growth in Iraq. 2gls regression model was used to account for possible endogeneity and reverse causality in the data set. The results from the analysis support the environmental Kuznets curve (EKC) theory which holds that income growth and environmental degradation have an inverse U-shaped connection. Suggesting that in the initial phases of economic expansion, environmental degradation is allied with per capita income; then, after a specific threshold is reached, it is inversely correlated with per capita income. The findings of the study will be useful for law makers in implementing policies and strategies related to greenhouse gas emissions and economic expansion in Iraq.

LIST OF ABBREVIATIONS

GHG	=	Greenhouse Gas
CO2	=	Carbon Dioxide
EKC	=	Environmental Kuznets Curvature perspective
GDP	=	Gross domestic product
2SLS	=	Two-Stage Least Squares
OLS	=	Ordinary Least Squares

CONFLICT OF INTEREST

None.

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