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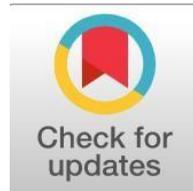
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Measuring and Analyzing the Relationship Between Global Warming and Economic Growth Using the Vector Autoregression (VAR) Model: Iraq as a Case Study for the Period (1990–2016)

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Abstract

General Background: Global warming driven by carbon dioxide emissions has become a central challenge to economic systems, particularly in developing and oil-dependent countries. **Specific Background:** Iraq, as a rentier economy heavily reliant on oil production, faces rising CO_2 emissions alongside fluctuating gross domestic product growth, especially during the period $1980-2016$ marked by wars, sanctions, and structural instability. **Knowledge Gap:** Despite increasing environmental deterioration, limited econometric evidence exists on the dynamic relationship between global warming and economic growth in Iraq. **Aims:** This study analyzes the short-run and long-run interactions between CO_2 emissions and GDP using annual World Bank data and the Vector Autoregression model. **Results:** Unit root tests confirm stationarity at first difference, while the Engle−Granger test indicates no long-term cointegration between the variables. VAR estimates reveal weak but positive short-run interactions, where economic growth slightly increases emissions and past emissions strongly determine current emission levels, with model explanatory power reaching 96% and 89% respectively. **Novelty:** The study provides a structured econometric assessment of environmental and economic dynamics in Iraq using VAR modeling for the full $1980-2016$ period. **Implications:** Findings highlight the short-term mutual dynamics between oil-driven growth and emissions, underscoring the need for diversification strategies and climate-focused economic policies in Iraq.

Highlights:
- No Long-Run Equilibrium Detected Between CO_2 Emissions and GDP.
- Short-Term Dynamics Show Weak Reciprocal Interactions.
- Past Emission Levels Strongly Determine Current Emission Trends.

Keywords: Global Warming, Carbon Dioxide Emissions, Economic Growth, Vector Autoregression, Iraq

Introduction

The serious issue of global change is of notable harm on the economies of countries everywhere and this is because the propellers of it are continuing unopposed such as carbon dioxide, which sits on the top of the culprits list of this phenomenon.

In this ordeal, the developed countries find themselves in a position of great losses from heat shocks and with disruption in supply chains. Oil producing nations like Iraq face a rather conundrum in that while the extraction is continuing, there is no escape of inflation of GDP as resultant emissions continue to gather pace.

A close look at recent work on the subject scholarship uncovers for us these contradictory outcomes. Nordhaus charts the overall burden noticed in advanced economies, yet the continued reliance on the production of this chemical substance springs up unexpected short-term gains that make up the leeway when it comes to agriculture and tourism. A typical testament to this tension is Iraq, a country the oil fields of which account for 60% of its revenue which obviously boosts the growth of its energy sector while at the same time pumping out even more warming-producing gases. The effects of the scorching summer are already making their imprint on the water-scarce farms, especially palm groves are clearly on the wane, and wetlands are drying up. In this study, we try to assess these effects using techniques championed in the field.

Research Problem & Significance

The research importance comes from its taking into account the fact that while oil production could give ab initio boom for the economy of the country, it also fires up the serious issue of the global warming that could in turn result in long-term adversities. These include the drying of Euphrates, one of the two main rivers of the country in addition to the deterioration of palm groves, as well as mass migration from dust-plagued cities. Thus, we believe this is of enough value to pursue as a topic given its serious challenges and concomitants.

Research hypothesis

The study works on the hypothesis that steering away from oil reliance and following a diversified economic modus operandi would lower the overall carbon emissions in the country and thus contribute to cushioning climate change in informative ways.

Research Purposes

The inquiry is built around achieving two central aims:

1. To make clear the intellectual and scientific basis for understanding the phenomenon of global warming.

2. To investigate and by extension quantify how this phenomenon has interacted with the economic trajectory of Iraq for the period between 1980 and 2016.

Research Methodology

In terms of methodology, this study works through an inductive and deductive approach in order to analyze and measure the research variables scrutinized in this study. We particularly use the Vector Autoregression (VAR) model to fulfill this purpose.

Section One: Conceptual Framework

First: The concept of global warming: An Overview

This means the aggregate rise in the average temperature of the Earth as a direct consequence of greenhouse gases permeating in the atmosphere, which in turn brings about changes in climate patterns worldwide . gives a similar description to this but adds oceans as another victim of its consequences. Along a similar line,. refers as well to the precipitating factors of it such as burning fossil fuels or deforestation, which ensnare heat that would otherwise escape from the Earth.

To explain it in simplistic terms, sunlight streams in through the air where clouds as well as specks of dust hanging high. Bright spots on the ground and ocean tops bounce a percentage of about 30% right back out to empty spheres while most of the rest go unopposed into waters, winds, and solid earth below. Earth here soaks it up then fires off the extra as radiant glow and heat waves heading out to cool everything off. However, some of that get grabbed by a range of culprits such as carbon dioxide, water steam, ozone shields, methane clouds, and more floating around up there and ultimately sending the warmth dropping back down to ground level and that is in fact the crew we lump under greenhouse gases .

Carbon dioxide, as can be understood from the above, takes the lead role in kicking off climate mess and heat surges as it pours out from a kaleidoscope of sources such as huge fuel fires in factories, power hubs, vehicle fleets, and all sorts of other spots, to say the least. The big push of industry through the 1900s stacked up CO_2 piles and similar stuff widely loosening its grip on the greenhouse door and pushing air temps higher all around the world .

Second: The emergence and development of the global warming phenomenon

The first period of the history of the emergence of the concept of global warming and interest in it, until about 1945, was one that witnessed the development of theories of specialization in the cause of climate change, and the acceptance of the idea that this climate was unstable during the nineteenth century as evidence of past ice ages was found. However, during this first period, the investigation of the magnitude and direction of climate change took a hit by the dearth of enough evidence about the potential effects of this phenomenon if it occurred, and the focus was actually on positive outcomes such as improved weather conditions and agricultural conditions especially in northern latitudes .

In the mid-19th century, the impact of solar variations on climate garnered a lot of conjecture when an 11-year cycle of sunspot preparation was observed, with Nobel laureates (Svante Arrhenius), Following the path set by Joseph Fourier and John Tyndall, attention was geard to the "greenhouse effect" being born out of how atmospheric gases like CH_4, CO_2, and water vapor block thermal radiation alongside thoughts on whether factories burning fuel everywhere could push forward the warming effect witnessed in the world.

Svante Arrhenius figured out that emissions from human industry with the scale of it could one day lead to global warming, but other scientists rejected his idea and called it wrong. Back in 1938, G.S. Callendar put forward that growing carbon dioxide amounts were behind climbing worldwide heat, though the bulk of experts at the time dismissed his take as far-fetched or outlandish. Pure chance, however, brought a handful of investigators in the 1950s around to seeing concrete potential to tap in the idea of planet-wide heating, and by the early 1960s Keeling had clocked sky-high CO_2 traces building fast in the air .

In the latter half of the last century, the potential impact by mankind on the climate became apparent, though the full dimensions of the problem were not really pressed home until the 1970s. Since then, significant progress has been made in fathoming out the different parts of the complex climate system (the atmosphere, hydrosphere, biosphere, cryosphere, and to some extent the lithosphere) .

It happened that in 1965, scientists on the President of the United States' Science Advisory Committee raised concerns about the "greenhouse effect." In a report titled "Restoring the Quality of Our Environment," the scientists suggested that the rise in atmospheric temperatures was a result of the accumulation of carbon dioxide. However, the term "global warming" was not constructed by geologist (Wallace Broecker) until 1975, and it took some years before the issue gained traction in terms of understanding .

Nevertheless, the World Meteorological Organization (WMO) did not begin expressing concern until the late 1970s when the World Meteorological Organization stared ringing the bell over how people's actions, above all, pumping out CO_2, might flare up risky heat-ups down in the troposphere. Through the 1980s, alarms over that heat-trapping setup kept coming up from researchers which had a peak in 1988 (the year North America went through a severe heatwave and drought) these concerns extended to the political arena. The World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) created the Intergovernmental Panel on Climate Change (IPCC) to investigate and report on the scientific evidence regarding climate change and potential international responses to it (soas.ac.uk).

So, the interest in this phenomenon in terms of scholarship started in the 19th century when concepts like the "Ice Age" and the "greenhouse effect" got tossed around in scholarly circles in the second decade of the aforementioned century, when researchers from that particular era started figuring out traits of specific vapors and how they latch onto the sunlight-sourced energy. Although it took a while for both ideas to enjoy acceptance, researchers initially put forward that slim blankets of sky gases sparked the big chills of ice eras while those thicker layers pushed for balmier climes .

Third: Causes of Global Warming

Global warming is caused by a variety of reasons, some natural and others human-made, as follows:

A- Natural causes: These relate to the natural factors that lead to global warming, such as:

(1) Carbon dioxide (CO_2), a chief greenhouse gas, ensnares about half the heat held by trace gases up in the outer sphere and is answerable to roughly 50% of the greenhouse effect. The pace and length of warming levels during the last century outpaced anything we witnessed in the previous thousand years . Global warming comes largely from CO_2 in addition to other pollutants piling up in the air, where they snag sunlight and the Earth's infrared solar radiation. In normal circumstances, that energy would slip off into space but these long-lasting gases keep a tap on it and thereby skyrocketing temperatures as a result .

CO_2 accounts for 77% of human-made emissions. It is followed in importance by methane, which makes up 14% of these emissions, and then nitrous oxide at 8%. Burning fossil fuels is often thought to be the seed corn of carbon dioxide emissions, but these emissions also come from deforestation, the decay of organic matter, changes in soil, certain industrial processes like lime production (such as in cement manufacturing), and carbon oxidation (like in steel production). Methane is released during the extraction, refining, and processing of oil, gas, and coal, as well as from livestock, rice cultivation, and waste management practices. Most nitrous oxide emissions stem from soil cultivation, though some are also released during combustion and certain industrial processes .

(2) Eruptions from volcanoes can be held accountable for notable CO_2 levels in the atmosphere. They actually pump out

around 25 million tons yearly, creating pockets of elevated concentrations close to the vents .

(3) Solar activity and forest fires: Changes in solar activity, like flares and sunspots, affect temperature changes, as well as changes in the sun's magnetic activity and variations in wavelengths and ultraviolet waves, which all help increase the heat the sun emits to the Earth. As for forest fires, they happen on a grand scale resulting in an spike in greenhouse gases and polluting the air .

B- Climate change, in the opinion of scientists, comes principally from people's unprecedented use of fossil fuels for energy purposes. The large-scale burning of these fuels opens the gates for elevated amounts of adverse gases into the air, which are key drivers of climatic shifts. Fossil fuels play a major role here as they make up 80 percent of the globe's energy supply, per the Australian Greenhouse Office .

Human contributions to the amount of atmospheric dust come in different forms. For example, dust can emanate from agriculture, and several types of industrial operations churn out all sorts of airborne dust related in one way or another to whatever they burn or manufacture. On top of that, vehicle exhaust be it cars, trucks, and planes gives out a cocktail of contaminants with some kicking off as dust particles, others becoming dust by way of atmospheric chemical reactions. .
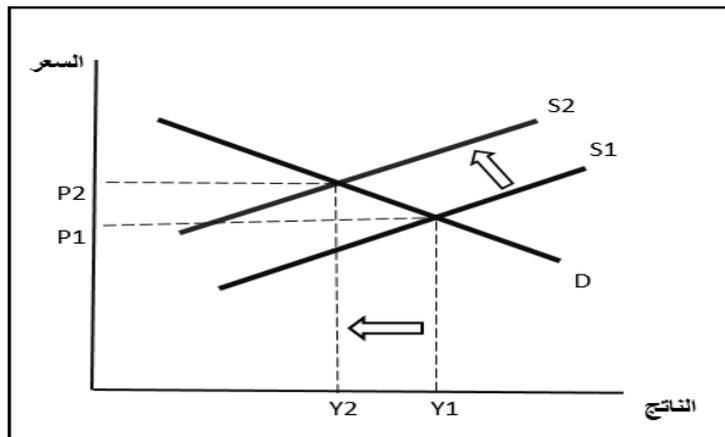
Fourth: The Effects of Global Warming on Economic Growth

Over the long haul, the warming effect stands to pull down economic improvement in net terms. While undoubtedly climate shifts might boost some players, these will be in turn hurting others depending on the warming level recorded, but hotter temperatures will ripple damage far and wide, as one would normally expect. Of note here in terms of expectations are the biggest hits which show up in a variety of ways such as wrecked property and infrastructure, slashed worker output, swathes of displaced people, and high security risks. As temperatures climb higher, the scales will tip ever more strikingly against the winners .

Developing countries, suffer greatly from this phenomenon more than rich countries, even though the former do not contribute to a great deal to the total greenhouse gas emissions that largely lie behind this phenomenon. This is due to the vulnerability of their economies to the many repercussions and effects of climate change, as well as their limited ability to adapt to these changes. On the other hand, negative effects on the economy are evident more noticeably in Asia, especially Southeast Asia, which face the risk of losing up to 8.8% of its GDP by 2100 .

This phenomenon deals economic growth a blow like a supply shock as it slashes total supply no matter the price and shoves the supply curve leftward (S1 to S2). Also, output descends into Y2 as a result, while prices climb to P2

Figure (1): The impact of global warming on aggregate supply and aggregate demand

Source: Prepared by the researcher based on

Statistics tell us that there has been an increase in economic losses as a result of extreme weather events by 100%. The losses were roughly put at around $63.6 billion in 2015, climbing to $122 billion in 2018. Moreover, the Fifth Assessment Report by the Intergovernmental Panel on Climate Change (2014) states that further temperature increases of about 2°C are likely to cause losses equivalent to 0.2% to 2% of global GDP. Countries around the equator and in the southern hemisphere are guessed to see some unwanted outputs in terms of economic growth. Also, a 2°C rise in warming could reduce annual economic growth by up to 2% for a large number of countries worldwide .

Fifth: Measures and means to reduce the phenomenon of global warming

There are a set of measures that can be used to tackle and reduce global warming, divided into two main parts:

A- Procedural methods or means, which include treaties, agreements, conferences, and international, regional, and local efforts to generally mitigate climate change. Some of the most important of these agreements (for more, see the United Nations Climate Change Report: 2013) are:

1. Back in 1992, at the Earth Summit, 197 nations put their names as signatories to the UN Framework Convention on Climate Change. This aimed to help stop human meddling from taking the climate into perilous territory.
2. Then came the Kyoto Protocol three years later in 1995, which is a deal that pinned legally binding cuts on emissions produced by developed countries. Its first round ran between 2008−2012 while the follow-up kicked off January 1, 2013, wrapping it all up in 2020. Today a total of 192 parties claims allegiance to it.
3. Fast-forward to 2015: Paris 21st COP meeting came with a landmark pact to gather worldwide action which entailed ensuring temperature rates to well under 2°C past pre-industrial baselines and ideally capping at 1.5°C. 184 countries now stand by this agreement.
4. The 2019 Climate Summit came into existence on September 23, focusing on game-changers in this regard like heavy industry, nature fixes, urban zones, energy shifts, resilience builds, and climate cash.
5. Nationally Appropriate Mitigation Actions in 2007 as voluntary actions (including policies, programs, and projects) by developing countries to reduce greenhouse gas emissions. This mechanism is aimed at helping developing countries that want to lower their emissions (see more, ESCWA report, 2017).
6. Appropriate national mitigation measures in 2007, considered voluntary actions (including policies, programs, and projects) by developing countries to reduce greenhouse gas emissions, are a mechanism aimed at helping developing

    countries that want to lower their emissions (see more in ESCWA report, 2017).

The technical means and methods adopted to mitigate or reduce global warming are as follows:

1. Energy conservation: this particular procedure stands as a key strategy here if we are to reduce total consumption or maximizing efficiency in whatever we do use. Waste no more than necessary. Switching to a compact fluorescent bulb from a standard one can cut CO_2 emissions by 500 pounds annually. So, this is overall one proper way to fight this negative process and start relying on renewable energy as an alternative to traditional energy sources.
2. Recycling: this is another effective way to reduce global warming which means making a new product from a previously used material. According to the Recycling Campaign (2013), recycling soda cans reduces the emissions by 95%, which is a huge drop. This could significantly slow global warming if carried out seriously .
3. Improving water heating efficiency: Heating water consumes a lot of energy. Luckily, improving efficiency in this area is easy and cost-effective. Things like washing clothes in cold water, insulating the water heater, and setting its temperature 20 degrees Fahrenheit lower (from the unnecessary default high setting of 140°F), can make a big difference. About 90% of the energy used by this type of sets is spent on making hot water, which is often unnecessary thanks to modern detergents. Just washing clothes in unheated water can cut 18 million tons of CO2.Replacing current faucets and showerheads (especially those made before 1992) with high-efficiency units will cut down on wasted water flow and reduce emissions by more than 60 million tons of carbon dioxide .
4. Increasing vegetation cover: Planting more trees can pull CO_2 from the air and clean it up in the process . Also, by changing traditional farming practices that rely on materials that boost emissions, whether carbon-based or not, and reducing deforestation and the fragmentation of farmland for industry and housing .

Methodology

Using annual time-series data for the period 1980−2016 and a quantitative analytical approach, the study sought to analyze the relationship between global warming and economic growth in Iraq, obtaining World Bank data. The variable of carbon dioxide (CO_2) emissions (Kton) were used to proxy global warming and development was proxy by gross domestic product (GDP) (current prices). This involved aggregating and arranging the data, followed by estimating its growth rates to visualize the variations in response to key economic and political events. We tested the data for unit roots with the Augmented Dickey−Fuller procedure using 3 specifications (intercept, intercept and trend, and none); the results are shown in Table 3 to ensure the data was adequate for econometric modelling. The results of the unit root test revealed that both variables are found to be stationary at the first difference. Then used the Engle−Granger cointegration test to verify if there was a long-run equilibrium relationship between CO_2 emissions and GDP. Since no evidence of cointegration has been so far detected, the Vector Autoregression (VAR) model has been used to reflect short-run dynamic interactions among the variables. While the optimal lag length was determined by the Schwarz information criterion, the model estimation was performed using E-Views 10. Diagnostic and stability tests were poured, by analyzing the inverse roots of the characteristic polynomial for each model in order to confirm the validity of the specified ARIMA model where all the roots had to be inside the unit circle confirming the model being stable. This methodology framework, gave us the opportunity to provide an assessment for both short-run and long-run interactions between environmental and economic indicators in Iraq.

Result and Discussion

Section Two: The Practical Aspect

First: The reality of global warming and economic growth in Iraq

Table (1) shows the path and development of the global warming phenomenon, expressed as gas emissions.CO2 and economic growth as expressed by GDP at current prices in Iraq for the period (1980-2016).

Table (1) / gas emission rateCO2 and GDP in Iraq for the period (1980-2016)

growth rate GDP (4)	growth rate CO2 (3)	Gross Domestic Product at Current Prices / Million Dinars (2)	Emission ratio Co_2/ kilo ton (1)	Years
63.50943	-46.7744	559265	49907.87	1990
-31.7418	-9.34362	424516	45643.15	1991
63.12033	22.78536	1151084	59112.04	1992
64.21281	6.707564	3216469	63362.09	1993
80.60412	11.17565	16583258	71334.15	1994
75.23217	4.054254	66954829	74348.43	1995
-2.99278	-6.97515	6500924	69500.65	1996
56.92796	-1.74469	150931440	68308.88	1997
11.86921	5.614106	171258475	72371.91	1998
50.30803	-0.12175	344640126	72283.9	1999
31.36532	0.222717	502136999	72445.25	2000
-21.5399	15.11193	413145685	85342.09	2001
-0.71092	2.197848	410229274	87259.93	2002
-38.6575	4.233741	295857886	91117.62	2003
44.42455	20.13114	532353587	114084	2004
27.60403	-0.49422	735335986	113523	2005
23.07232	-14.936	955879548	98770.65	2006
14.23691	-58.9086	1114558134	62155.65	2007
29.02082	33.27297	1570260616	93149.13	2008
-20.1946	10.90144	1306432004	104546.2	2009
19.35605	6.817885	1620000000	112195.5	2010
25.34562	18.00397	2170000000	136830.4	2011
14.56693	11.40605	2540000000	154446.7	2012
7.163743	6.742245	2736000000	165612.7	2013
0	0.609595	2736000000	166628.5	2014
-32.0463	0.38583	2072000000	167273.9	2015
-0.22864	11.9892	2067273367	190060.6	2016

Source: Tables (1) and (2) World Bank data. Tables (3) and (4) show the simple growth rate calculated by the researcher using the following equation. R = 100

It is clear from the table above that the research variables were unstable in view of the economic, political and social conditions Iraq has gone through. As for the carbon dioxide emission rate, there was a noticeable increase in emissions, which was because of the outbreak of the Iran-Iraq War in the 1980s, along with the heavy use of weapons, fires, and destruction of agricultural lands caused by the war. The situation did not change and almost remained the same in the 1990s, especially in the early years due to the start of the Second Gulf War between Iraq and the U.S.-led coalition and the resulting destruction of infrastructure and the use of banned weapons like uranium. Emissions continued to ascend throughout this period, reaching 74,348.43 kilotons in 1995, then decreased over 1996 and 1997, before rising again in the following years to 72,371.91 kilotons, with a growth rate of 5.614106 in 1998. This increase was due to the spread of local generators across the country, which had a role in higher emission levels.

The period after 2003 and what followed was no better than its predecessor, as the emission growth rate continued to increase, as well as the emission levels, especially during the Second Gulf War, until emissions reached 91,117.62 kilotons in 2003. The situation remained the same throughout this period, particularly after the terrorist organization ISIS took control of many areas and destroyed infrastructure and lands. Emissions reached 165,612.7 kilotons in 2013, with a growth rate of

6.742245, and continued to rise to 190,060.6 kilotons in 2016, with a growth rate of 11.9892.

Iraq's environment has experienced deterioration in all its essential elements over the past years, which was a primary cause of global warming and its increase. This is attributed to several factors :

1. Cutting down more than 10 million palm trees and thousands of other trees because of wars, the fragmentation of agricultural lands, and general neglect of the agricultural sector by relying on imports from abroad. This deprived the Iraqi environment of one of its most important purifiers and allowed for an increase in pollution caused by gases that contribute to global warming.
2. Draining the marshes and water bodies in southern Iraq, which wrecked havoc on the environment and climate.
3. Burning huge amounts of crude oil and its derivatives, as well as rubber tires, directly into the air, in addition to using chemical weapons, including carbon soot and its oxides, sulfur, and nitrogen, which cause air and soil pollution.
4. More than 2 million cars entered Iraq since 2003, combined with aging transportation vehicles and widespread use of electric generators, all of which led to massive environmental pollution from fuel emissions. This is in addition to many other factors like drought, low rainfall, and declining environmental and cultural awareness.

As for the GDP, during the 1980s it experienced a decline due to the Iran-Iraq war. After being 157,707 million dinars in 1980, it dropped to 113,469 million dinars, with an annual negative growth rate of (-38.9869).

However, despite that war, it was observed that there was a gradual improvement throughout the war years, reaching 204,079 million dinars in 1989 with a positive annual growth rate of 4.780992. As for the 1990s, the GDP at current prices saw a big surge, reaching 559,265 million dinars in 1990 with an annual growth rate of 63.50943. But this does not really reflect what actually happened. The rise in GDP at current prices was not real; it was a natural shift in the Iraqi dinar's value versus the dollar sparked it all naturally, namely from 3 dollars per dinar to 1 dollar for 3,000 dinars. This deterioration in in value precipitated by a strict economic embargo on the country during the 1990s because of Iraq's invasion of Kuwait, affected the economy as a whole. So even though GDP at current prices kept rising, the increase was just superficial, a result of the new currency issuance that the previous political regime used at that time and up until early 2002.

The economic situation, including the country's GDP, did see some improvement, especially after signing the memorandum of understanding with the United Nations (Oil-for-Food) in 1996, reaching around 410,229,274 million dinars by 2002. However, after the fall of the previous political regime, GDP in 2003 suffered a setback as a natural result of the war that engulfed the country, which also led to a change in the political and economic system, dropping to 295,857,886 million dinars with a negative annual growth rate of -38.6575%. But it saw a noticeable upsurge in 2004, reaching 532,353,587 million dinars with an annual growth rate of 44.42455%. The upward trend continued for the most part, except for a setback in 2009, but it rose again until 2014, when it fell once more because of the fact that some Iraqi cities falling to ISIS and the start of the war against the organization, in addition to the global decline in oil prices and its reflection on the domestic economy. The decline continued until 2016, reaching 2,067,273,367 million dinars with a negative annual growth rate of -0.22864.

Second: Analyzing and measuring the relationship between global warming and economic growth

1- The standard model: For the purpose of conducting standardized tests, the economic variables specific to the Iraqi economy were adopted as follows:

- Global warming, expressed as the percentage of carbon dioxide emissions.CO_2.

- Economic growth as expressed by Gross Domestic Product at current prices.

- The time span from 1980 to 2016, as the latest updates for carbon dioxide emissions are available.CO_2 in World Bank data stops at 2016.

2- Unit Root Test: Table (2) shows the results of the test. It is clear that the series for the carbon dioxide emissions variable is stationary at the difference whether there is a intercept, a intercept and trend, or without a intercept and trend. The series for the gross domestic product variable is also stationary at the first difference whether there is a intercept, a intercept and trend, or without a intercept and trend.

Table (2) / Unit Root Test

Variables	First difference		
	Intercept	Intercept and trend	Without an intercept and trend
CO_2	-5.225*** 0.000	-5.357*** 0.000	-4.739*** 0.000
GDP	-4.623*** 0.000	-4.662*** 0.003	-4.398*** 0.000

The table was prepared by the researcher based on the E-Views 10 program.

- Stationary at the 10% level – ** Stationary at the 5% and 10% levels – *** Stationary at the 1%, 5%, and 10% levels.

With variables reaching stationarity at the first difference I(0), the Engle-Granger cointegration test comes next to discern for any link tying the pair together.

3- Table 4 in the Engle-Granger test puts the tau-statistic clearly below 5% significance, so this means no cointegration between both, dependent and independent vectors. Null hypothesis holds as no long-term equilibrium linking them can be seen, alternative gets the boot. VAR test comes next.

Table (4): Engle–Granger Cointegration Test

Series: CO2 GDP

Sample: 1980-2016

Included observations: 37

Null hypothesis: Series are not cointegrated

Cointegrating equation deterministics: C

Automatic lags specification based on Schwarz criterion (maxlag=8)

Prob.*	z-statistic	Prob.*	tau-statistic	Dependent
0.0006	-30.56848	0.0859	-3.247727	CO2

0.0045	-25.10681	0.0897	-3.225495	GDP

The table was prepared by the researcher using the program. E-views 10

3- VAR Test for Research Variables: Table (5) shows the results of estimating the VAR model, and the following points are clear from the table:

1. The first model: Table (5) shows that a boost in economic growth, measured by last year's GDP, by one unit led to an increase in current year economic growth by 0.618 units. The again achieved in economic growth in the previous two years by one unit led to an increase by 0.332 units, which indicates continuous improvement from an economic perspective. The model also shows that an increase in economic growth in the previous year by one unit led to an increase in the greenhouse effect, measured by CO_2 emissions, by 0.191 units. An increase in economic growth in the previous two years by one unit led to a decrease in the greenhouse effect by 0.013 units. This means that the effect of economic growth on the greenhouse effect is still unclear, whether negative or positive. The explanatory power of the variables describing the changes in the second model, expressed by (R^2), reached 96%.

Table 5 from Model Two lays it out clearly on how the phenomenon of global warming ties into economic growth. A one-unit increase in warming from the previous year leads to just a 0.002-unit uptick in current-year growth. Stretch that to a one-unit rise over the past two years, and then you get a 0.025-unit boost. If we look at them closely, these are positive relationships, no doubt, but they are feeble in that global warming is not shaking up the economy in any big way. Shifting to warming's own momentum, a one-unit jump last year instigates a solid 0.893-unit increase this year. That is a strong, significant effect that points straight to how last year's carbon dioxide emissions heavily dictate the current level. On the flip side of things, the two-year cumulative effect on this year's intake of warming comes in negative at -0.1756 and is not statistically notable. The model as a whole holds up well with the variables under study accounting for 87% of the variation observed in these changes (R^2).

The two models show that there is a positive, mutually reinforcing relationship between global warming and economic growth. This relationship can be explained by the fact that Iraq is a rentier state heavily reliant on the extractive sector (oil), which in turn is one of the main sources of greenhouse gas emission. Since Iraq's GDP depends on oil for about 60%, any increase in this sector leads to higher economic growth as measured by GDP. At the same time, the more oil extraction gets the higher it results in CO_2 emissions. These two processes look inseparable and are in proportional capacity to the occurrence of each other.

Table (5) / Var Test for re search variables

Series: CO2 GDP

Sample: 1980-2016

Included observations: 37

Null hypothesis: Series are not cointegrated

Cointegrating equation deterministics: C

Automatic lags specification based on Schwarz criterion (maxlag=8)

Prob.*	z-statistic	Prob.*	tau-statistic	Dependent
0.0006	-30.56848	0.0859	-3.247727	CO2
0.0045	-25.10681	0.0897	-3.225495	GDP

The table was prepared by the researcher using the program. E-views 10

Model Stability Test: To check how valid and stable the model is, and to ensure it does not have issues like variance instability or error correlation, we will carry out a model stability test.

Figure (2) Model Stability.
Inverse Roots of AR Characteristic Polynomial
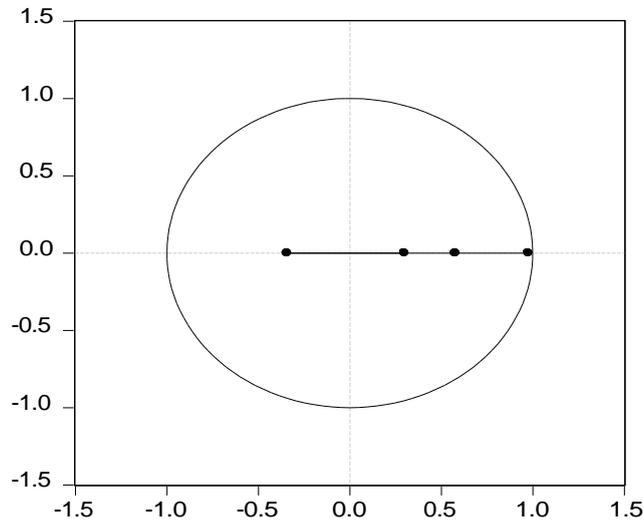
The table was prepared by the researcher using the program. E-views 10

The figure above shows that all coefficients fall below the one threshold and the roots are within the circle of unity.

Conclusions and Recommendations

First: Conclusions

- There is no denying that climate change, especially global warming, brings big trouble to ecosystems, human health, wildlife, and dashes any hope for steady economic progress.
- In Iraq, wars have cast a blight on farmland, reliance on oil pumps out CO_2 nonstop, generator fumes everywhere make things worse, and rivers are drying up, piling problem on top of another unlike richer countries that at least pretend to care.
- Advanced countries, widely cited as the worst offenders, drag their feet on reforms required to fight this calamitous effect while places like ours suffer more, as a result.
- Clinging to oil and gas production without clean alternatives, which are not unavailable, just keeps digging a deeper hole in the problem which is already broadening out.
- Studies on this are still really scarce among economists, mostly left to geographers, a matter that calls for the former specialists to follow in the footsteps of the latter.
- Economically speaking, there is no stable long-term link between warming (CO_2 emissions) and GDP growth here, but in the short run, weirdly enough, they feed off each other with oil booms boost GDP while emissions, which no one expected in a place like Iraq, surge along with it.

Second: Recommendations

1. Increasing attention to the issue of climate change, whether at the level of study or at the level of measures to mitigate it, especially global warming, as it is the most common phenomenon in the Arab region in general and in Iraq in particular.
2. It is necessary to have economic and geographical research centers that focus on studying this phenomenon in terms of climate, geography, and economics, in order to provide a broader understanding and more research focused on measurement, reporting, data, and related programs, as well as monitoring all activities that could exacerbate global warming, in addition to finding solutions to help reduce this phenomenon.
3. Iraq must take its role as a leading and proactive player in the region, both locally and regionally, in all initiatives and directions, and actively participate continuously in all fields, activities, and agreements related to climate change, engaging with them positively as it is one of the most affected countries.
4. There is a need for a national strategy focused on climate change that works to reduce global warming in the country through a set of laws and regulations, like stopping the fragmentation of agricultural lands, preventing violations, criminalizing tire and asphalt burning, and banning illegal brick factories and similar operations.
5. Seriously considering reducing dependence on oil and trying to find new energy alternatives, as well as genuinely addressing the electricity crisis, so we can stop relying on private and home generators in the near future.
6. Involving all relevant parties on the issue of global warming, such as the Ministries of Higher Education and Scientific Research, Education, Industry, Agriculture, Health, Environment, Oil, and others, as well as engaging the private sector and all civil society organizations to raise awareness and educate people about the dangers of this phenomenon and how to mitigate it.

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