ABDULMAJEED TSOWA MUHAMMAD

EXAMINATION OF THE EFFECTS OF ENERGY, ECONOMIC AND FINANCIAL DEVELOPMENT ON POLLUTION, A TIME SERIES ANALYSIS FROM THEPERIOD OF 1990 TO 2021 IN SOUTH AFRICA.

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Abdulmajeed TSOWA Muhammad

Supervisor
Asst. Prof. Dr. Ala Fathi Assi

Nicosia
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Approval

We certify that we have read the thesis submitted by Abdulmajeed TSOWA Muhammad titled **"Examination of the effects of energy, economic and financial development on pollution, a time series analysis from the period of 1990 to 2021 in South Africa."** and that in our combined opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Educational Sciences.

Examining Committee	Name-Surname	Signature
Head of the Committee:	Prof. TURGUT TÜRSOY	.....
Committee Member (Supervisor):	Asst. Prof. Dr. Ala Fathi Assi	.....
Committee Member :	Dr. Laith Tashtoush	.....

Approved by the Head of the Department

12./02./2024

Asst. Prof. Dr. Ala Fathi Assi

Head of Department

Approved by the Institute of Graduate Studies

...../...../20...

Prof. Dr. Kemal Hüsnü Can Başer

Head of the Institute

Declaration

I hereby declare that all information, documents, analysis and results in this thesis have been collected and presented according to the academic rules and ethical guidelines of Institute of Graduate Studies, Near East University. I also declare that as required by these rules and conduct, I have fully cited and referenced information and data that are not original to this study.

Abdulmajeed TSOWA Muhammad

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Abdulmajeed TSOWA Muhammad

Abstract

Examination of the effects of energy, economic and financial development on pollution, a Time series analysis from the period of 1990 to 2021 in South Africa.

Abdulmajeed TSOWA Muhammad
MSc, Department of Banking and Accounting

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This study examines the relationship between pollution and the financial, economic, and energy development of South Africa between 1990 and 2021 using a time series analysis. The study comes to the conclusion that although South Africa's urban population has a negative influence, energy consumption, economic growth, and financial development have a significant positive influence on pollution. The analysis also reveals the heteroskedasticity and multicollinearity of the data. In light of these findings, the government of South Africa is urged to pass legislation aimed at reducing energy consumption and increasing the use of clean energy sources. Furthermore, financial initiatives that encourage investments in environmentally friendly technology and support sustainable economic growth without endangering the environment should be supported by the government. In addition, it is important to put in place policies that aim to manage urbanization and support sustainable urban growth. Overall, this study advances our knowledge of the causes of pollution in South Africa and offers insightful advice to decision-makers who want to lessen its adverse effects. Granger causality tests and the Autoregressive Distributed Lag (ADF) model are used in the study to examine the variables' long- and short-term impacts. The findings indicate that while economic and financial growth have a negative influence on pollution, energy consumption has a considerable beneficial impact on it both in the short and long terms. Additionally, the causality tests indicate that there is a two-way causal relationship between pollution and energy consumption, meaning that both factors might increase at the same time. However, there is a single line of causality connecting economic and financial growth to pollution, meaning that as these two factors grow, pollution decreases. The results show that South Africa must create sustainable policies to lessen the negative environmental effects of energy use while fostering economic and financial growth.

Keywords: Energy consumption, economic development, financial development, pollution, Augmented Dickey Fuller **(**ADF**)** model and South Africa

ÖZ

Examination of the effects of energy, economic and financial development on pollution, a time series analysis from the period of 1990 to 2021 in South Africa.

Abdulmajeed TSOWA Muhammad

Supervisor, Asst. Prof. Dr. Ala Fathi Assi

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Bu çalışma, 1990-2021 yılları arasındaki verileri kullanarak Güney Afrika'nın enerji, ekonomik ve finansal gelişimi ile kirlilik arasındaki ilişkiyi zaman serisi analizi ile araştırmaktadır. Çalışma, Güney Afrika'da kentsel nüfusun kirliliğe olumsuz etkisi olduğunu, enerji tüketimi, ekonomik genişleme ve finansal gelişmenin ise önemli ölçüde olumlu etkisi olduğunu sonuçlandırmaktadır. Araştırma ayrıca verilerin heteroskedastik ve çoklu doğrusal ilişki içeren (multicollinear) yapıda olduğunu göstermektedir. Bu bulgular ışığında Güney Afrika hükümeti, enerji kullanımını azaltmayı ve temiz enerji kaynaklarının kullanımını artırmayı hedefleyen önlemler alması gerektiği konusunda teşvik edilmektedir. Ayrıca, yeşil teknolojiye yatırımı teşvik eden ve ekonomiyi çevreye zarar vermeden sürdürülebilir şekilde büyüten finansal gelişmeyi desteklemesi gerekmektedir. Bununla birlikte, kentleşmeyi yönetmeyi amaçlayan politikaların oluşturulması ve sürdürülebilir kentsel büyümeye destek verilmesi önemlidir. Genel olarak, bu çalışma Güney Afrika'daki kirliliğin nedenleri konusundaki bilgilerimizi ileri taşımakta ve olumsuz etkilerini azaltmak isteyen karar alıcılar için anlamlı öneriler sunmaktadır. Çalışmada Granger nedensellik testleri ve Otoregresif Dağıtılmış Gecikme (ADF) modeli, değişkenlerin uzun ve kısa vadeli etkilerini incelemek için kullanılmıştır. Bulgular, ekonomik ve finansal büyümenin kirliliği olumsuz etkilediğini, enerji tüketiminin ise kısa ve uzun vadede kirlilik üzerinde önemli olumlu etkisi olduğunu göstermektedir. Ayrıca nedensellik testleri, enerji tüketimi ile kirlilik arasında iki yönlü nedensel bir ilişki olduğunu göstermektedir, yani her iki faktör aynı zamanda artabilir. Ancak ekonomik ve finansal büyüme ile kirlilik arasında tek yönlü bir nedensel ilişki bulunmaktadır, yani bu iki faktör büyüdükçe kirlilik azalmaktadır. Sonuçlar, Güney Afrika'nın enerji kullanımının olumsuz çevresel etkilerini azaltmak için sürdürülebilir politikalar oluşturması ve aynı zamanda ekonomik ve finansal büyümeyi desteklemesi gerektiğini göstermektedir.

Anahtar kelimeler: Enerji tüketimi, ekonomik gelişme, finansal gelişme, kirlilik, Artırılmış Dickey Fuller (ADF) modeli ve Güney Afrika.

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List of Abbreviations

ADF	Augmented Dickey Fuller
ARDL	Autoregressive Distributed Lag Model
CO2	Carbon Dioxide
EKC	Environmental Kuznets's Curve
GMM	Generalized Method of Moments
FDI	Foreign Direct Investment
EIA	Energy's Energy Information Administration
PPM	Parts Per Million
GGI	Green growth Institute
WDI	World Data Indicator

CHAPTER I

Introduction

Earlier in the period, the issue of environmental pollution is developing into a critical fretting worldwide, particularly in developing countries such as South Africa. As the country continues to experience economic growth and development, it also faces environmental challenges that require immediate attention. The purpose regarding the inquiry is to look at the effects of energy until financial progress is made on pollution in South Africa during the event from 1990 to 2021, using time-series analysis.

South Africa is a country rich in natural resources, including coal, gold, and platinum. Energy production and consumption are crucial components about each nation economic development. However, it also culminated in significant environmental challenges, such as air and water pollution. Financial development, on the other hand, has also been a critical component of South Africa's economic growth. As such, it is imperative that you look at the way monetary and energy growth affect the level of harmful emissions in the country.

The study will use time-series analysis to examine the tie among energy and monetary growth and pollution in South Africa over the particular time from 1990 to 2021. The study will consider the following variables: intake of power, economic growth, together with pollution. Intake of power will be measured in terms of electricity consumption, while financial development will be measured by how big the financial system is, how much number of stock market transactions, and the value of international trade. Pollution will be measured by the level of air and water pollution in the country.

The paper's findings will contribute to the awareness of the bond among energy and monetary development and pollution in South Africa. The study will also offer ideas into the procedures and rules that can be put into practice to minimize the harmful impacts of power and monetary growth regarding what's around you. Overall, the study's outcomes will be useful for policymakers, environmental advocates, and other stakeholders involved in South Africa's sustainable development.

South Africa is a developing country with a rapidly growing economy that has led to significant environmental challenges, especially with regard to pollution. The national dependence on coal and other fossil fuels for energy production, coupled with monetary advancement, has led to a boost in levels of air and water pollution. As such, it is essential to look toward the relationship among monetary growth along with power and pollution in South Africa.

The experiment will conduct a time-series analysis to look into how pollution is affected by financial additionally power development in South Africa from 1990 to 2021. The experiment will consider several variables, including intake of power, economic growth, along with pollution.

Intake of power will be measured in terms of electricity consumption, which is an important source of power in South Africa. Electricity consumption has increased rapidly over the preceding few generations, with an annual revenue growth of 3.3% from 1990 to 2021 (World Bank, 2021). This growth has resulted in increased carbon emissions and other forms of pollution.

Financial development will be measured by how big the lending sector is, how much number of the commodity trade transactions, and the value of international trade. The lending sector is crucial for financing energy projects and other economic activities that impact the environment. The number of stock market transactions and the value of international trade can indicate the nation's degree of job creation, which can impact pollution.

Pollution will be measured by the quality of liquid and oxygen in South Africa. The state of the air poses a significant ecological challenge in the country, particularly in urban areas where industrial activities and transportation contribute to high levels of air pollution. Water pollution is also a critical issue, particularly in mining areas where water sources are often contaminated by mining activities.

The study's findings will contribute to the understanding of the bond among energy and monetary development and pollution in South Africa. The study will also provide insights into the policies and strategies that can be implemented in order to minimize the harmful impacts of power and monetary growth on the environment.

1.2 Background of the study

According to Cunha-e-Sá (2008), A highly emphasized greenhouse gas (GHG) in the natural world is carbon dioxide (CO2), via been there for more than a century.

Thus, since 1987, the planet's ecology has been threatened by CO2 accumulation, according to the Brundtland Commission study (GEO4 2007).

Without a doubt, photosynthesis, animal grazing, human respiration, and rock weathering all produce CO2 (also known as carbon in the general term for all greenhouse gas emissions) naturally (Goodland and Anhang 2009).

Human activity is responsible for the highest quantities because of ignition, agricultural procedures, forest clearing, and the burning of fossil fuels for energy (GEO4 2007).

Deforestation for urban and agricultural expansion releases carbon dioxide that has been stored in soil and trees and decreases the capacity of the ecosystem to absorb CO2 going forward (IPCC 2007).

Global climate change is a result of increasing CO2 concentrations, which induce a slow warming of the Earth's surface, oceans, and atmosphere (Cunha-e-Sa (2008) and Raghbendra and Whalley (2001).

Changes in weather are defined as "a change in climate caused directly or indirectly by human activities that alter the composition of the atmosphere" (GEO4 2007: 517). It affects the global atmosphere and modifies natural climatic conditions observed variability over comparable time periods.

According to the 1987 Brundtland Commission Report, "humanity is capable of creating sustainable development."

This result demonstrates Linkages between environmental protection and growth quality (GEO4 2007: 6).

This result has sparked a discussion among economists over the bond among greenhouse gases and progress. By examining the consequence of power, the marketplace, and money trends on CO2 emissions levels this investigation adds to the ongoing discussion.

1.2.1 Carbon dioxide emissions and Income

There are differences in the theories explaining how ambient quality and growth are related according to Panyotou (2000: 1; 2003: 45), such "on one side are those who argue that economic growth must cease and the world must take a transition to a steady-state economy" Refer to Daly (1991); Jansson et al. (1994), Meadows et al. (1972); for example. Conversely, some argue that economic expansion is the surest path to environmental progress (see, for instance, Beckerman 1992; Bartlett 1994). According to Beckerman, becoming wealthy is ultimately a surefire method to improve the climate, given the substantial association between revenues and climatic activity (Panayotou 2003).

Richer countries tend to attract "clean" home and factories that use a lot of materials produce low carbon emissions, while poorer countries, like those in Africa, tend to attract "dirty" domestic and industrial activities that produce high carbon emissions (Hoffmann 2011).

Put another way, industrialized nations possess the financial and economic clout to produce pristine, low-CO, environmentally friendly, and energy-saving technologies, but poor nations do not

As a result, many emerging nations continue to employ antiquated technology (Hoffmann 2011). At least 80% of people utilize inexpensive, filthy fuels like coal, kerosene, and conventional wood-burning stoves to cover their home energy needs in nations including Afghanistan, Chad, Ghana, India, and China (Duflo et al. 2008).

Studying on the bond among job creation and sustainability has involved examining CO2 emissions and income (Bertinelli and Strobl 2005; Pauli 2003; Mazzanti and Musolesi 2013; Piaggio and Padilla 2012; Moomaw and Unruh 1997). Still, it is thought that omitted variable bias could pose a threat to these investigations (Stern 2004). Consequently, it becomes necessary to consider whether income level is the sole significant determinant associated with development (Panayotou 1997). Because of this, other researchers have

considered various economic factors in their research, including the percentage in the total economic activity (GDP) of the sector the loan that is to GDP ratio, population size, trade openness, rate of illiteracy, and energy consumption, additional variables that explain Almeida and Carvalho (2010), Panayotou, Peterson, and Sachs (2000), Owoye and Onafowora (2013), and Shafik and Bandyopadhyay (1992) are a few examples of these other researchers. The chapter's section 1/6 provides a detailed presentation of the explanatory factors (financial and economic) that were taken into account for this study.

1.2.2 Carbon dioxide emissions and revenue growth

The dramatic rise in GHG emissions in the post-industrial era in light of human activity compared to pre-industrial levels is unmistakable evidence of a decline in environmental quality. Furthermore, considering how quickly CO2 concentrations have risen throughout time, it is thought to pose the biggest threat to the ecosystem. The amount of CO2 in the atmosphere caused by burning fossil fuels is 280 parts per million, in other words, during the pre-industrial era, and it averages about 403 ppm in 2016. Stated differently, the CO2 in the air in 2016 is 145% greater than pre-industrial levels as due of the process of burning oil and gas and producing concrete (World Meteorological Organization, 2017). Furthermore, in 2016, CO2 emissions accounted for 72% of all releases of greenhouse gases worldwide, with the industry sector and the generation of heat and electricity contributing 50% of these emissions. The six nations with the highest CO2 emissions in 2016 were Japan, the EU28, the US, China, India, and the Russian Federation. These nations were accountable for roughly 68 and 63 percent of the world's CO2 emissions emissions and total greenhouse gas emissions, respectively, according to Olivier et al. (2017).

Nonetheless, in 2016, CO2 emissions rose in India (- 4 %) and the EU (28) (0 2%), while they fell in the Russian Federation (-2 %), the US (-2 0%), Japan (-1 2%), and China (- 0 3%). (Olivier and others, 2017). Additionally, the range of air pollutants that contribute to environmental degradation is

significantly wider than just CO2 emissions (eg air, water, soil contaminants, noise and sunshine glare). In fact, the vast bulk of empirical research has employed CO2 emissions as a measure of pollution. Its significance for climate change and the data's accessibility may have led researchers to concentrate more on its related effects than on other kinds of pollution. It is acknowledged that Dasgupta, Laplante, and Mamingi (1998) and Lanoie, Laplante, and Roy (1998) included financial development in the discussion of development factors crucial to environmental quality. An organized financial sector, according to Dasgupta et al. (1998) and Lanoie et al. (1998), can offer suitable incentives for companies to lower CO2 emissions in developing nations. For instance, there might be a favorable response if the public and financial markets are properly and purposefully told that a corporation has taken steps to improve pollution control. A favorable reaction like this could result in financial benefits like an increase in the market valuation of the business.

However, the public and financial markets will react negatively to environmental news, such as lawsuits for breaking environmental standards (Ibid). Institutions of finance could potentially offer rewards offered via reducing administrative costs and loan interest rates to businesses looking for funding to buy greener technology and participate in low-emission projects (Shahbaz, Solarin, and Mahmood 2012b). Additionally, this industry can help financially struggling businesses buy environmentally friendly machinery and encourage the influx of foreign capital (Claessens and Feijen 2007). Thus, The ability of the business community to provide financial services that are superior to other environmentally friendly programs Monetary growth is crucial for the relationship between growth and an improved CO2 environment because it reduces CO2 emissions in emerging economies (Piñeiro, Tamazian, and Varlamannati, 2009).

On the relationship among progress alongside environmental quality, however, there is another way of looking at financial development.

Accordingly, the financial system will primarily support the development and consumption of associated carbon-related items as emerging nations draw in material-intensive products (Hoffmann, 2011). (World Bank 2000)

Even with sound environmental policies, this will result in higher emissions (Jensen, 1996).

Sadorsky (2010) provided empirical evidence in support of this theory, finding a favourable correlation among the growth of finances alongside the the need over oil and gas, which ultimately results in a rise in energy use and the release of CO2.

1.3 Research Objectives

The major goal intends to investigate and assess how South Africa's energy, financial, and economic developments affect emissions, with a particular emphasis on the 1990-2022. The main

The current study explicitly sought to:

a) Inspection of a reliability of the EKC for CO2 emissions in South Africa by panel analysis.

b) Examine the bond among revenue growth and CO2 emissions in South Africa.

c) Analyze how financial development affects CO2 output in South Africa.

d) Analyze the impact of energy on CO2 output in South Africa.

e) Examine the unique forms of CO2 emissions in South Africa using the disparate pasts of colonization.

1.4 Statement Of The Research Problem.

Financial development can help import clean technologies, which could boost economic activity and eventually result in a lower CO2 environment in Sub-Saharan Africa, in light of the theory underlying the bond among financial development and CO2 emissions (Frankel and Romer 1999). But under "business as usual," the financial sector provides the capital for resource exploration and extraction, which raises South Africa's atmospheric

emissions (Sadorsky 2010; UNCTAD 2012). Thus, CO2 emissions may be affected by the area of finance while simultaneously pushing technological developments that may reduce South Africa's CO2 emissions. As such, emphasizes the idea that SSA's environmental performance is significantly and deterministically impacted by financial expansion (Tamazian et al., 2009).

To address the topic Research has speculated using the Environmental Kuznets Curve (EKC) model to investigate the bond among fiscal additionally financial development affects CO2 emissions. This has led to an inquiry regarding if growth-related elements—aside from monetary considerations—are crucial for a reduced CO2 circumstances. Like that research' findings reveal disparities. An N-shape was discovered by some (Laisney, Nguyen-Van, and Azomahou (2009), some (Carvalho and Almeida 2010) found an inverted U-shape, while some (Pandelis 2012) found a monotone form. Is the EKC algorithm's dependent form present in SSA? is among the inquiries this research attempts to address. Regarding the subject of turning points, as stated by Stern (2004:1424), “including more low-income countries in a cross-country study might yield a higher turning point”. Research involving a larger percentage of nations with low incomes in what they chose has came across fewer changes rather than inquiries involving fewer percentage of economically poor countries. The turning point was found by Agras and Chapman (1999) to be $13,630 per capita income for a sample of 34 developed and developing countries. Dijkgraaf and Vollebergh (2001) calculated the per capita income to be $13,959 for 24 OECD countries. members. Specifically for SA, this study looks into the empirical question of how true this suggestion is.

1.5 Limitation Of The Study.

The study main limitation is that it only catters for one African country and it does not represent or the findings cannot be used as the sample for other countries since they are different economic and financial activities in each and every county.

1.6 Research Questions

This are the issues that should be addressed in this study:

1) Is there an EKC for carbon emissions in South Africa?

2) What connection exists among growth in South Africa's economy and CO2 emissions?

3) What relationship exists between South Africa's CO2 emissions and monetary growth?

4) In how does this affect power consumption on CO_2 emissions in South Africa?

1.6.1 Research Hypothesis

The body of evidence and theories reviewed in the chapter before, in addition to the research questions that were introduced in the above all provide the foundation for the study's hypotheses. First off, the affluence factor is the main indicator that can be utilized to mitigate environmental difficulties (such carbon emissions), according to some academics (see, in this regard, Beckerman 1992; Grossman and Krueger 1991). Put another way, witnessing an increase in revenue. In their opinion, to be economic prosperity and affluence rise, so does environmental degradation. When one reaches a certain economic (or prosperity) level, the surroundings gets nicer. This link is described by the UNCTAD (2012) presents the Environmental Kuznets Curve (EKC) hypothesis.

Carvalho and Almeida (2010) and Moomaw and Unruh (1997), among other scholars, contend that CO2 emissions defy the EKC. They predicted the resulting U-shaped inversion pattern of EKC ideally just appear early regarding the connection among pollution and business expansion. At a higher income level, one more pivotal moment would provide the N-shaped curve. It's the EKC, however, might apply to CO2 emissions in SSA due to the region's propensity for a with regard reduction in CO2 emissions for each main power group used, (or decarbonization). Roberts and Grimes 1997; Schmidt et al. 1998 so as to respond that inquiry "does the Environmental

Kuznets Curve (EKC) model relation shape exist in SSA", The following theories are proposed:

H_{01}There is hardly any correlation among income (Y) and carbon dioxide (CO2) emissions.

The EKC's opponents (Neumayer 1998; Dasgupta et al. 2002) have pleaded with regulators not to adopt the EKC's "grow first and clean up later" strategy. They think lawmakers can improve the environment by consistently penalizing dangerous polluters. Countries may therefore observe an EKC that is more rounded and fewer compared to the traditional EKC (also known as the revised EKC). Such theory is looked at using the following premise.

H_{02}: There is no revised EKC because Evidently isn't any noteworthy positive correlation among economic development and CO2 emissions.

The research notes that income is non the sole one factor which may reinforce as well as mitigate ecological issues, even though wealth and carbon emissions may be associated. As a result, the research has employed numerous vectors of financial and economic development variables (Grunwald and Martinez-Zarzoso, 2011; Tamazian et al., 2009)). The literature's contributions on the rate at which jobs are created, aspects of prosperity, in addition to the percentage of GDP allocated to agriculture are all addressed by these theories "what is the effect of economic and financial development on CO2 emissions in SA".

H_{03}: CO2 emissions and measures of economic growth do not statistically significantly correlate.

H_{04}: Signals of fiscal growth and carbon emissions do not appear to be correlated.

Keeping these developed hypotheses in mind, the immediate section describes the empirical models for this investigation.

1.7 Research Model

Its empirical theory used in the inquiry, which is because it's theoretical models, is as follows.

$lnE = \beta_0 + \beta_2 lnY + \beta_k lnZ + \varepsilon$ ………………………………………………………….(1)

In this case, β0 stands for the constant, β2, β3, β4, and βk for the relevant explanatory variable coefficients, lnY for the income logarithm, lnZ for the other variable vector, and ε for the error term. The symbol lnE stands for the logarithm of environmental degradation. Each individual emits the following amount of carbon dioxide (CO2): the study's stand-in for deterioration of the ecosystem. The GDP per person (Y) is computed using the coefficients of lnY as a proxy for income. lnZ represents the vector of the selected financial and economic development indicators.

$lnCO_{2it} = (lnY, lnT, lnEc, ln\text{Gd}D, ln\text{GcF}, ln\text{En}, lnUp)$ …………………(2)

Equation also includes the following additional economic development variables: the inflation rate (lnπ), the percentage of GDP allocated to trade (lnT), the percentage of GDP allocated to agriculture (lnA), and the total quantity of main power consumed by an individual (lnEn). This is since job growth is a result of defined by more than just GDP per capita. The financial development Representative variables include foreign exchange rate (lnO), level of subsequent monetary growth (lnGcf), GDP. We test the sixth hypothesis. The controllable variables are the population density (lnP) and the share of the urban population to the total population (lnUp). They function as tests of robustness to examine how the predicted results of the tested theories. The premise behind this is that developing countries have seen a rise in environmental pressures due to population growth, gentrification, and the structural transition from agricultural to industrial activity (UNCTAD 2012).

1.8 Concepts and Theories

A number Many of the adverse effects of climate change are covered in the first chapter, such as drought, water scarcity, and erratic weather patterns. Along Guinea's and East Africa's coasts, these impacts are particularly apparent. It is acknowledged that these extreme weather events are the primary cause of the hunger and malnutrition that these communities experience (Schaeffer et al. 2014). Due to rising sea levels and frequent heavy

precipitation events, people who live in low-lying deltas in Asia and Africa are especially susceptible to recurring and catastrophic flooding. History will never forget the September 2014 floods in India and Pakistan brought on by the monsoon in Kashmir (UN Global Compact et al. 2011Dengue fever, malaria, and water-borne infections are among the infectious diseases that are impacted by climate change in the Sub-Saharan African nations (SSA), primarily in according to UN Global Compact et al. (2011), Nigeria, Kenya, Ethiopia, Eritrea, and Rwanda.

Mitigating the effects of global warming is now a worldwide benefit to society. Because there are insufficient political or economic frameworks to ensure effective responses to its negative effects (Cunha-e-Sá 2008). Governments and international organizations, as noted in the literature, have been working with the public and private sectors worldwide to implement a variety of policies and initiatives aimed at reducing greenhouse gas emissions by moving away from economies that heavily rely on carbon. The present section discusses a number of these initiatives and rules in an attempt to increase our understanding of the variables causing climate change as well as potential mitigation strategies.

1.8.1 Steru Look over

The worst market failure in human history, carbon emissions are the result of firms' inability to fully recover the costs from the beginning within the context of the technological advancement, of their production (2008 Andrew). Rather, they externalize the remaining expense by releasing emissions into the atmosphere, which causes global warming, which is then borne by society as a whole (Stern 2006). Due to the adverse effects of climate change, corporations have benefited from the unfavorable outside influence brought on by rising carbon emissions in the natural world, but societal welfare has decreased (Andrew 2008). Fiscal matters effects of climate change, as well as the benefits and drawbacks in cutting the greenhouse gas emissions that cause it is crucial to take notice of, because the implications of anthropogenic climate change will last for many generations (Sussman et al., 2014). Stern (2007) states.

Sir Nicholas Stern oversaw a revaluation of the financial implications of climate change at Gordon Brown's request, the former British Chancellor of the Treasury. The Stern Review is the name of the result of this. The request was made within an attempt to increase the general understanding about it problems caused by climate change as well as potential solutions (Nordhaus 2007). According to the Review, welfare would eventually suffer and irreparable harm would result from ignoring climate change. As a result of this finding, urgent efforts to cut greenhouse gas emissions have been made, that can support mitigate the chances associated with weather variability (2007 Stern). This recommendation aligns in conjunction with the IPCC's.

The paternalistic view, or almost nonexistent moments price reduction, is the most divisive assumption in the view since it is at odds with current market savings and real interest rates (Nordhaus, 2007). Because of this, Hope (2006), Nordhaus (2007), Mityakov and Rohl (2009), and a few other researchers estimated reduced rates of reducing GHG emissions and the price of carbon on society that which was done in the Review. Temporal discount rates that were appropriate for market interest rates and savings rates were employed by these analysts. found. Weitzman (2007) makes a case for Stern by pointing out that economists are aware that the choice of discount rate is the most uncertain component of the economics of climate change. Because generations born later have a greater time discount rate, Stern (2009) argues that the adoption of the paternalistic approach was also justifiable because it eliminated discrimination based on an individual's date of birth.

Conversely, Neumayer (2007) suggests that rather than "discounting," the central query for the Review's discourse ought to be "to what extent does climate change inflict irreversible damage to natural capital" The Review implied the injury is replaceable using words the effects of shifts in the global environment proportionate to gross domestic product failing to acknowledge this issue. This shouldn't be the case, according to Neumayer (2007), as many of the effects of climate change aren't worth that much money.

We applaud the Review for making contributions instead of focusing only on differences. For tying climate change policies to both environmental and

economic goals, Nordhaus (2007) gave the Review high marks. Comparable to the IPCC, the Audit advocated for the implementation of suitable policy frameworks, such as those that promote the creation and use of advanced technology, especially in the field of power efficiency, and set a price on carbon through trade, taxes, or regulations (Stern 2007). Al Gore's (2006) book and movie about worldwide rise, according to Weitzman (2007), ignored this "inconvenient truth." The section that follows discusses climate change-related policy.

The main policy suggestion of the Review is that it is better to mitigate now rather than adapt later (Mityakov and Rűhl 2009). To effectively implement mitigation measures, attention must be directed toward the three sectors that account for the majority of greenhouse gas emissions in developing nations: deforestation, energy use, and agriculture (Stern 2006). Additionally, the As per Stern's 2007 review, the inquiry panel concluded that monetary organizations such as banks and capital markets should bear the primary responsibility of bringing up and assigning the necessary money for carbon-negative projects. Discovering what role has been played in the context of SSA thus far is one of the goals in the investigation.

1.8.2 Economic tools related to the environment

The typical welfare study revealed that mitigation efforts will effect all generations, which sparked debate over the urgency of reducing carbon emissions as soon as possible (Rezai et al., 2009). In Andrew (2008). This brought up the inquiry into how emerging economies ought to adhere to a "grow now, clean up later" growth model of wealthy nations (Van Alstine and Neumayer 2010). The impoverished are thought to give less thought to the atmosphere, at least from a theoretical standpoint (which will be covered in the next chapter). Instead, the emphasis is on intake (Hallegatte et al. 2011). When fundamental requirements are satisfied, and earnings increase, and increases in the percentage of charges collected by the authorities people start to appreciate environmental quality more (Everett et al., 2010). (2011) Halleggatte et al. Everett et al. (2010) claim that this compels the government to increase funding for environmental protection and remediation.

To address the subject at hand, the "grow now, clean up later" school of thought is flawed for various factors. For example, it could be more economical to control pollution during the initial phases in growth rather rather then have to pay more for maintenance afterwards since certain facilities are durable and might be challenging to adjust subsequently (World Bank 2012). Second, the irreversible character of the environment is overlooked in the reasoning. Replanting, for example, can revive destroyed trees in Kenya, but it cannot restore the potential for biodiversity (Hallegatte et al. 2011). The climate is also impacted by released CO2 because it endures an extended period in the air (World Bank 2012). (Everett et al. 2010)Thus, postponing cleanup potentially harmful.

To solve the shortcomings in the aforementioned reasoning, upcoming economies are recommended on becoming cleaner, that is, to aim for growth through the decrease of pollution (World Bank 2012). To support clean growth, or green growth, and to make it possible for mitigation actions to be completed over time at lower costs, Lecocq et al. (1998) suggest politicians to enact particular laws that promote growth with a small ecological impact (Hallegatte et al. 2011). The rules in question are financial devices which support the greenhouse gas (or "climate change") policies that are suggested by the Stern Review and the IPCC report. Fisher et al. (1995) distinguished between two categories of economic tools related to climate change: market-based and non-market. Some of the former are briefly explained in the following subsections.

An economy such as this would, in theory, only need market-based instruments to offset negative externalities such as the atmospheric build-up of carbon emissions if markets functioned perfectly. This is owing to the potential for increased administrative costs and decreased economic efficiency when employing both market- and non-market-based instruments (Gupta et al. 2007). In other words, in a market with perfect competition, market-based instruments have theoretical advantages like dynamic efficiency, like low-carbon technology, and static cost effectiveness, or the capacity to cut emissions at the lowest feasible cost to society (Stavins 1998).

However, in practice, barriers that were both domestic and global limited the efficacy of market-based devices Holden, 2009. The market failures that fall under this category include things such as dissimilar data access regarding carbon credits' accessibility and unfavorable distributional implications, such as the impact of market-based instruments is greater on families with lower incomes due to their cannot afford to replace their kerosene stoves with gas stoves. As such, explains why having instruments that are mix trade- and non-based is advantageous, since the former contribute to distributional equity by mitigating market flaws (e.g., by disseminating knowledge to the public) (Stavins 1997).

1.8.3 Carbon pricing, carbon trading, and carbon taxation

The cost of carbon may useful in two different ways. According to Carraro and Favero (2009), production activities can be changed to incorporate low-carbon and energy-efficient technology. For example, Kenyan homes and businesses can switch from fuel-powered energy systems to solar energy systems. Second, substituting lower carbon input elements for lower carbon input elements (such as Turkey's move from coal to natural gas) (Ibid.). Hepburn and Stern (2008) distinguish between three methods of putting in place a carbon price: by means of a trading system, carbon emission levies, or implicit pricing via regulations and standards. The goal of both the carbon tax and the trading scheme, notwithstanding their differences in design, is to obtain a specific abatement level at the lowest possible cost so as for success a comparable class of efficiency (Kasterine and Vanzetti 2010).

Under a trading plan, carbon prices are established by the market, but governments impose limits set by overall amount of emissions and distribute them as tradeable stipends (Benz and Trück 2006). Therefore, businesses that would incur penalties for exceeding their allotted amounts (cost on emissions) would purchase from businesses that haven't used up all of their allotted amounts (Carraro and Favero (2009) state that value is placed on drops). Market forces' ability to set a price on carbon is vital but insufficient given the urgent need to reduce emissions globally (Hepburn and Stern 2008). In this case, national as well as global laws and guidelines are relevant. Under a

trading structure with a lax cap, carbon prices are low, whereas stricter caps lead to more costly (Carraro and Favero 2009).

A government does not control the amount of emissions when it chooses in order to calculate the impact's cost using the carbon tax, also referred to as the the price of carbon (Barker et al. 2007). The cost of carbon is raised and the amount of emissions allowed is increased fortunately emissions stay to be excessive under the trading scheme is reduced for a predetermined amount of time (Kasterine and Vanzetti 2010). Because of its price volatility, the trading scheme is thought to be the greatest tool as it's allows for fewer drastic political adjustments than the carbon tax. The trading mechanism is also favored globally since it guarantees effectiveness and collaboration in order to achieve the reduction of emissions target (Stern and Hepburn 2008). Still, because of the trading scheme's high transaction costs, market inefficiencies (such collapsed carbon credit prices), and uncertainty, domestic mitigation efforts in developing nations are not favoured by it (Stavins 1997). Thus, even in the event that the carbon tax is well-designed, its implementation and raising may prove politically difficult (akin to a labor strike) (Barker et al. 2007). Nonetheless, it gives governments a respectable annual cash stream that they might utilize to entice private capital to sponsor clean technology projects in underdeveloped countries (IMF 2008). Kasterine and Vanzetti (2010) assert that in response to changes in the economy, the adaptability and cost equilibrium are also enhanced by the carbon tax. According to Goulder and Pizer (2006), these factors account for the estimated welfare losses under the carbon price as opposed to the trade system. In 1990, Finland imposed the first-ever carbon price, and fifteen other nations have since enacted comparable laws (OECD 2013). Since 2001, all cars in Zimbabwe are subject to a carbon tax, as reported by Nhamo and Inyang (2011). Mauritius (Dalmazzone 2015), South Africa (Kim 2015), and Ethiopia (IMF 2016) have all taken action to implement a carbon tax by 2016. Before going on to supplementary tools built around demand, it could not exist just to discuss how the carbon market lowers emissions internationally in order to properly address the carbon pricing and trading systems.

1.8.4 The Kyoto Protocol

An international pact known as the Kyoto Protocol was created in 1997 during the UNFCCC's in Kyoto, Japan, for the third COP session. After being approved by at least 55 nations, or at least 55% of the world's GHG emissions, the Protocol went into force in February 2005 (Barker et al. 2007). Table A.I. lists the legally mandated goals for each of the 37 advanced nations that make up the Annexe I countries. Other developing nations are not subject to Annex I's emission duties for decrease. The Protocol's implementation is referred to as the "Marrakesh Accords" (NRG4SD 2011). Conclusion The GHG emissions of the I countries need to be lowered (on average) by 5.2% from 1990 levels between 2008 and 2012. Nhamo (2009b). Thus, in spite of the convention's encouragement not to, developed nations have committed to stabilizing greenhouse gas emissions under the Protocol. Grunewald and Martinez-Zarzoso (2011) found that nations that accepted the Protocol and made emissions commitments released less CO2 than comparable nations that did not.

The "Doha Amendment to the Kyoto Protocol" was passed the same year that Canada ceased ratifying the Kyoto Protocol. The primary goal of this adoption was to reaffirm the nations listed in Annex I commitment in relation to the United Nations 2014 report on the Kyoto Protocol for the years 2013–2020. On the ninetieth day following the filing of documents of acceptance by of the 192 parties to the Kyoto Protocol, at least 144, the second dedication time will start with the UN. According to the UNFCCC website (unfccc.int), as of October 2016, 71 countries had ratified the Doha Amendment, including 18 in Sub-Saharan Africa.

1.8.5 The Economy of Ecology

In 2008, during the height of the world financial crisis, The Global Green New Deal (GGND) was promoted by the United Nations Environment Programme (UNEP) (Barbier 2009). In order to lessen the effects of and get ready for climate change, this 2009 agreement called on countries to support the transition to a greener economy. Both public and private sector investments are required to lower carbon emissions, improve energy and

resource efficiency, stop the demise regarding ecosystem services and biodiversity, and encourage the expansion of the green economy's employment and income (GIZ 2013).

The assortment of additional laws and government expenditures modifications, and pricing adjustments that the GGND suggests be implemented in order to shift from business as usual (BAU) to a green economy is listed below (UNEP 2011). To reach net neutral GHG emissions, maybe act as a carbon sink, and reduce deforestation while boosting reforestation, more ecologically friendly farming practices must be used (Ibid.). Utilizing renewable energy to reduce energy poverty and replace energy produced by fossil fuels is another investment (UN DESA et al. 2013). This includes funding non-motorized transportation, BRT, rail and water transportation, as well as other environmentally friendly transportation initiatives (UNEP 2011). Therefore, for both rich and developing countries, the investment path towards a green economy takes into account environmental, economic, and developmental factors (UN DESA et al. 2013; 2011 UN Global Compact et al.)

In order to prepare the workforce for the shift to a green economy, identical expenditures on labour, such as knowledge, consciousness, instruction, and ability upgrading programs, are also required (UNEP 2015a). Complementary pricing and policy reforms, including clean investments, as previously mentioned, pave the way for the shift to a green economy. Clean investments are encouraged by the appropriate application of corrective taxes, subsidies, and other market-based mechanisms (UNEP 2011).

Sub-Saharan African nations are among those that have actively and resolutely followed the green economic path since 2008 (UNEP 2015a). Therefore, South-South collaboration will also be necessary to facilitate a seamless shift to a green economy. Put another way, developing countries that have effectively adopted green economies may be able to provide other developing countries with helpful ideas, information, and technology to assist them in addressing problems that are comparable to their own (UNEP 2011). It is crucial to expedite the post-Kyoto framework (UNEP 2011) in order to

hasten and streamline the transition to a green economy, as multilateral environmental agreements (MEAs) are necessary for this (GIZ 2013). We'll discuss SSA's regional efforts to combat climate change and advance the green economy later. Although the precise amount of money necessary for green The vast sums at stake in the world economy are unpredictable (2011 UNEP). Consequently, the GGND urged countries to set aside a sizeable amount of money from stimulus programs to the approved ecological domains (UN DESA, 2012). Banks and the savings industry are also anticipated that it will be capable to supply capital required for both sectors of the economy to make the switch to a green economy. Among other financial institutions, insurance companies and pension funds are becoming more aware about it lower risks involved with creating green portfolios, for example. In a similar vein, retail and commercial banks are developing green financial solutions (UNEP 2011).

For a smooth transition after launching In addition to public financing and bank loans, a green economy and green funding instruments such as the Green Climate Fund Carbon Funds, Climate Funds, and (GCF) (described below) are required. Thus, in the event that the earlier investment package is not implemented, regulations, and funding choices, the path to a green economy remains challenging (UNEP 2011). To make this a reality, more work was required, and the major focus of the 2012 Rio+20 Conference was expanding the ecological simplicity in general way to speed up environmentally friendly growth (UN DESA 2013). "The future we want," the Rio+20 conclusion text, urges all developed nations to build their own strategies for a sustainable economy backed by the United Nations for less developed nations (United Nations 2012). In order to assist developing countries in making the Global Green Growth Institute's (GGGI) shift to an ecologically conscious economy was established (Kabaya 2012). The following list of two well-known green economy initiatives might assist you in spotting and grabbing opportunities that will guarantee the shift to an ecological economy.

According to Nhamo and Swart (2012), the first stock exchange in South Africa is the Johannesburg Stock Exchange (JSE). Sub-Saharan Africa to

implement the Carbon Disclosure Project (CDP) and a Socially Responsible Investment (SRI) Index. These disclosure indicators serve many purposes, among them informing investors and consumers about a company's environmental impact and its endeavours in assisting South Africa in its shift to an environmentally friendly economy (2012a UNECA). With any luck, this will raise market capitalization to the point that South African businesses are encouraged to lessen their environmental impact. In South Africa, carbon capture and sequestration is being carried out using rehabilitated mines. When their mines reach the end of their lucrative lives, the nation's mining businesses are anticipated to set aside funds during the operations for defence any closing costs. For example, De Beers grows mushrooms underground in mine shafts as part of the Kimberly project (UNECA (2012a).

With its cogeneration plant, Mumias Sugar Company Limited, Kenya lowers carbon emissions by producing energy from burning bagasse, a byproduct of sugarcane (UNEP 2014). An additional business that backs this strategy is Eskom, a power company in South Africa (UN Global Compact et al. 2011). Eskom prioritizes generating electricity and power using technology that produces fewer emissions.

South Africa and Kenya both seem to be setting the standard for other countries to follow, even though Ethiopia, Mauritius, and Rwanda have also seen to be taking the shift to a green economy seriously (Nhamo 2013). According to the IPCC's climate change model, the transition must be completed by 2050, requiring a significant amount of work (Huq 2011). As a result, other countries need to take the lead and take note of the crucial lessons that the front-runners have taught us.

1.9 Future Study

This study only focuses on one country and the researcher encourages some studies to focus more on panel studies taking into considerations economic regions.

1.10 Research Structure

This investigation is set up as follow the first chapter includes the issue statement, research questions, aims, hypothesis, significance, and scope of the study in addition to pertinent background information on the economics and governance of the changing climate. This part covers the green economy, financing for carbon emissions and climate change, and international initiatives and tools for lowering CO2 emissions.

The literature is reviewed in the second chapter. This includes the accepted theorizing underpinning, the empirical investigation, and the conceptual issues study methodology, comprising data description, model construction, estimating procedures, data analysis methods, and study design, is covered in the third chapter. The study's limits, results, conclusions, suggested policies, and topics for further research are covered in the fifth and final chapter. Results estimation and interpretation are covered in the chapter four.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction.

A country's overall health can be inferred from its GDP growth, which measures growth in the economy. The aggregate GDP is market value of all finished goods and services produced by an economy in a single fiscal year. Since capital formation and investment both contribute to GDP growth, most nations concur that investment and economic growth are strongly related. Economists that advocated capital formation as a way to boost GDP and saw investment as a spark for a country's economic growth included New Classical and Marxist economists. Investment-related increases in capital goods spur the production of other goods, which in turn increases growth and income (Anwar and Sampath, 1999). Since the GDPs of nations with high investment to GDP ratios are greater, more capital is needed to increase output. In addition, the endogenous growth hypothesis contends that investment is required for sustained economic growth. Empirical research has additionally illustrated the significance of funding improving economic performance since it promotes a generation regarding new an occupation, innovation in the advancement of technology, as well as the adoption of creative production methods. Tadele (2014) asserts that investment-based capital accumulation promotes sustained economic expansion. In any nation, there are two types of investments: those made on a personal and professional level. The term "public investment" describes the money that the government sets aside for a range of services, such as education and health. The main driver of private investors' investments is profit. When it comes to steady economic growth, empirical research has shown that investments made by the private sector are superior to those made by the public sector. This is so because investments made by the private sector promote innovation, the creation of jobs, boosted earnings and improved human resource performance. As Majid and Khan (2008) found, economies grow more quickly in countries with higher levels of private investment. Tadele (2014) also noted that robust economic growth resulting from private investment is

correlated with lower levels of corruption and other comparable factors. Similarly, because capital from personal investors is more effective along with transparent than governmental investment, Muhammad and Shaheen (2016) showed that private investment affects economic growth more than the latter. It is therefore crucial for advancing economic development. Prioritizing more private investment has been implemented within trying reducing unemployment and encourage a growing economy, especially in emerging economies. Private investment drives growing economy, however, it's additionally the primary source of environmental problems because rising production raises pollution levels. It's the largest challenge facing all economies, according to some research In 2016, Cederbary and Snobohn. According to Yousaf et al. (2016), there is a positive correlation between environmental degradation and Pakistan's GDP per capita, energy consumption, and foreign direct investment (FDI). The analysis contends that increasing FDI and GDP should not come at the expense of decreasing carbon dioxide (CO2) emissions. Considering that more than 60% of global warming is caused by CO2 emissions (Sinha and Bhatt, 2017).

The environmental Kuznets Curve (EKC) hypothesis was first introduced in the well-known study by Grossman and Krueger (1991). Since then, researchers have empirically examined it using a variety of environmental quality measurements in several nations. There is variation in the conclusions reached after multiple investigations. The EKC theory is supported by certain studies (Grosman and Krueger, 1991; Selden and Song, 1994), but it is refuted by other research (Saboori et al., 2012). The EKC states that when income levels rise, environmental degradation first rises, stabilizes, and then starts to reduce following a tipping point.

This brief survey must include the theoretical framework and empirical research in order to give a thorough understanding of the subject. This section's two subsections are devoted to the theoretical and empirical literature on the connection between energy consumption and financial development.

Financial development, energy use, and economic growth

The relationship between production per capita and energy use as well as financial development (a different indicator) was examined by Sadorsky (2010) and Levine (1999). The investigation's findings demonstrate that monetary growth influences power use in a favourable way. Many studies in the theoretical and empirical domains have documented the intricate bond among output growth and financial development (Kaminsky and Schmukler 2003; Claessens and Laeven 2003; Shahbaz and Lean 2012). monetary deregulation is viewed by Sadorsky (2010) and Beakert and Harvey (2000) as a risk-sharing component that could reduce equity costs and boost investment, which would ultimately boost economic development. According to Shahbaz and Lean (2012), if the current state of the economy is not carefully assessed, activities taken for financial liberalization and development may have a negative effect on it. Extra and creative investment opportunities and financial system elasticity are produced by the competition between domestic and international banks operating within a country. The bond among monetary growth and output growth is strengthened by this elasticity (Shahbaz and Lean 2012; Mankiw and Scarth 2008; Sadorsky 2010, 2011).

As stated by Khan and colleagues (2019), the connection among rising production and rising energy consumption cannot be supported by a the specimen bimodal method by itself. Individuals suggested including monetary information pertaining regarding the business industry, such as bank and financial institution credit. They continued by suggesting that population, trade opportunities, labor force involvement, and urbanization could all have an impact on energy use. They argue that the global panel's overall energy consumption is positively impacted by factors related to financial institutions and economic growth. However, Evidence is presented by Karanfil (2009) that swap rates as well as interest rates affect energy pricing, which in turn affects energy consumption. In this regard, Stern (2000) drew attention to the equation's removal of significant elements.

2.2 Theoretical Framework

Bother over the impact of market activity regarding the scenery are said to have originated from Reverend Thomas Malthus' critique of poverty alleviation initiatives in the 19th century (Raymond 2004). He said that insufficient rescue efforts damage the ecosystem and jeopardize humanity's the capacity to feed upcoming generations. Discussions regarding the bond among sustainability and growth have continued while have been dominated by the "limit to grow" argument presented by Malthus and the idea that economic expansion is the way to both ecological and individuals success (Raymond 2004).

Ehrlich, Holdren, and Commoner developed the IPAT equation in 1970 and 1972, respectively, to determine the variables that affect the level of ecological harm throughout the course of growth. It is anticipated that the degree to which an economy approaches sustainability will be determined by the IPAT equation, represented by Equation 3. Three factors affect the environmental effect: population (P), wealth (A), and technology (T). The environmental effect is represented by I. Population growth is thought to put more stress on the environment, but technology advancements can also possess a favourable or adverse effect on the environment (UNCTAD 2011). Growing wealth would inevitably result in more waste and pollution. $I = P \times A \times T$…..……..(3)

Numerous changes have been made to the IPAT equation. Martinez-Zarzoso and Grunewald (2009) highlight that the primary shortcoming of the IPAT equation is its accounting nature, which prevents it from accounting for the impact of factors that are not proportionate to Equation 3.1's right side. To address this, Rosa and Dietz (1997) rewrote the the stochastic the formula known as Stochastic Impacts by Regression on Population, Affluence, and Technology (STIRPAT) that provides a more sophisticated approach to IPAT. $I_i = \alpha P_i^{\beta} A_i^{\gamma} T_i^{\delta} \varepsilon_i$ . . . (3.2)

The variable α represents the constant term, β stands for population, γ for wealth, δ for technology, and the error term is the environmental impact of nation I. In formula 3.2, Rosa and Dietz (1997) did not proceed to determine the manner in which technology influences environmental effect; instead,

they treated T as an error term. York, Rosa, and Dietz (2003) enhanced T is able to assess the impact of technology by adding as the error term in STIRPAT (Martinez-Zarzoso and Grunewald 2009).

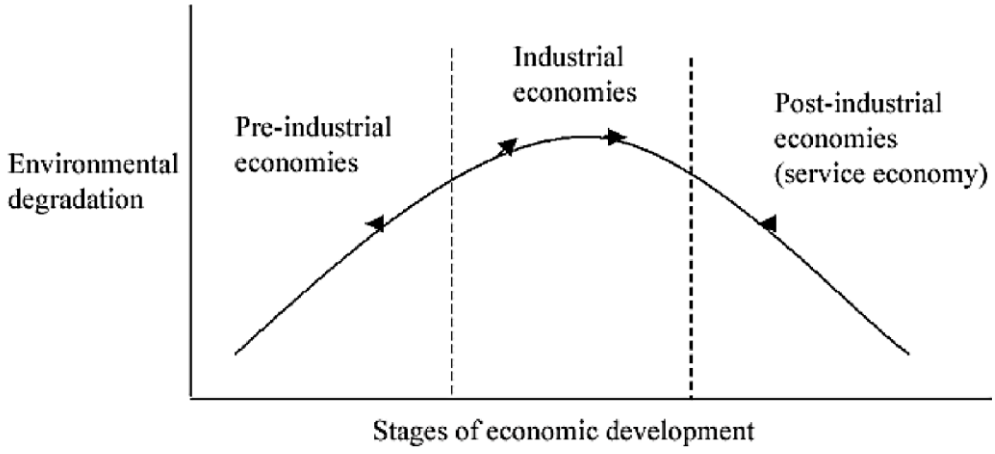
Numerous research indicate that the wealth component is the key to resolving environmental problems. They argue that although environmental quality improves once a certain income, or level of affluence, is reached, environmental deterioration increases with per capita income and growth in the economy. According to the Environmental Kuznets Curve (EKC) theory, environmental factors to economic growth (UNCTAD 2012).

The World Bank popularized the EKC concept in its 1992 World Development Report (WDR), though they did not use that term. The study came to the conclusion that more economic activity invariably results in environmental degradation based on antiquated assumptions about technology, preferences, in addition to expenditures made on the environment (Stern et al. 1996). The term "EKC" was first used in a scholarly work by Selden and Song (1994), citing Panayotou's 1993 publication in the Research Working Paper Series of the World Employment Programme (Agras and Chapman 1999). The EKC hypothesis states that destruction of the natural world is influenced by income. It is said that this one is unstable since there are various relationships depending on income levels for wealthy and poor countries. Figure 1.

It is possible to describe the structure of the EKC in terms of an approach by which business growth is essentially transforming. Early development, or the transition from As illustrated in Figure 1, between a pre-industrial and an industrial economy characterized by a decline in the ecological condition improves as the share of industry rises and the share of agriculture falls. This would result from giving labour-intensive jobs in the financial sector preference over those requiring personnel, which will raise output, per capita income, and consumption gradually. Environmental standards are expected to rise as society transitions from an industrial to a post-industrial economy, which is marked by a drop in the share of industry and an increase in the percentage of services. As a result, at the tipping point (According to UNCTAD (2012), the ecological indicators in Figure 1 would begin to

improve under industrial economies. Picture 1 demonstrates that, at this early stage of development, the sole causes of breakdown of nature as a whole of both quantity and severity are the effects of subsistence economic activity, or agriculture. As industrialization grows, so do waste creation and resource depletion along with increased agricultural and resource extraction. The growing slope of the curve in Figure 1 represents this.

Later stages of development witness the creation of increasingly efficient technologies, a structural shift toward information-based businesses and services, and a rise in the market for superior environmental products. This causes the curve to change, and as a result, environmental degradation gradually decreases (Panayotou 2003; Moomaw and Unruh 1997). This explains why the curve in Figure 1 has a decreasing curve.



An upscale good is ecologically friendly that influences the EKC's behavior based on income. Early in the course of economic development, environmental quality deteriorates because consumer spending won't be substituted for funds allocated to environmental preservation. After individuals have consumed something to a certain degree (or wealth), people begin to demand higher investments in better environments. Thus, following the tipping era, pollution and degradation are shown to be declining in environmental indicators (Moomaw and Unruh 1997; Galeotti 2003).

Growth offers an extra interpretation of EKC's geometry. Population growth is slowed down in wealthier economies because their residents tend to be more educated and to have fewer children. There is less demand on natural resources

as a result of the slower rate of population growth, which lessens destruction of ecological health. The EKC's form can alternatively be explained by the notion that inadequate environmental quality is usually the outcome of early growth. The poorest developing nations, in particular, lack the means and resources to implement clean technologies. However, as countries adopt clean technologies and get wealthy, the quality of the environment improves. (UNCTAD 2012).

2.3 Emperics

Many studies operate, with varying degrees of success, employed the EKC hypothesis to empirically investigate the bond among monetary growth and CO2 emissions. Monetary growth, energy consumption, and CO2 emissions were found to be negatively correlated in certain research (Shahbaz et al., 2013; Jalid and Feridun, 2011); positively correlated in other studies (Tang and Tan, 2014; Islam et al., 2013; Shahban and Lean, 2012; Sadosky, 2011). Likewise, different investigators discovered that the financial development had diverse impacts on greenhouse gas emissions. According to Zhang (2011), for instance, financial intermediaries make loans more accessible to consumers, which raises demand for homes and appliances like air conditioners, refrigerators, and cars. Comfort-enhancing factors all result in increased CO2 emissions. The second factor that positively affects CO2 emissions as a result of financial development, according to Sehrawat et al. (2015), is investment. Consumers are encouraged to invest in start-ups and businesses by the increased availability of credit facilities from financial intermediaries, which raises CO2 emissions. Third, monetary growth was discovered by Tamazian and Rao (2010) significantly affects FDI inflows, boosts economic growth, and reduces CO2 output. Fourthly, studies by Kivyiro and Arminen (2014) and Tamazian et al. (2009) demonstrated how financial development speeds up industrialization and economic growth while also increasing pollution. Most empirical studies found a one-way bond among fiscal growth and CO2 emissions EKC, which was modeled by researchers according to GDP expansion as well as power usage 2015 saw Albiman et al. Moreover, Tamazian and Rao (2010) discovered a positive cointegration among monetary growth and CO2 emissions in twenty-four transition countries; Sadorsky (2011) discovered a comparable relationship for nine CEE countries; Al-Mulali et al.

(2013) discovered a comparable relationship for MENA countries; and Mohapatra and Giri (2015) discovered a comparable relationship for MENA countries in addition to India. Jalil and Feridun (2011) discovered a negative correlation in China between the two, though.

The relationship between GDP growth and CO2 emissions has been studied by researchers Yang et al. (2007), Song et al. (2008), Dhakal (2009), Jalil and Muhammad (2009), Fodha and Zaghdoud (2010), and Wolde (2015). The loss of biodiversity is linked to the EKC hypothesis, which is supported by all of the investigations eventually declines as a result of economic growth. However, the EKC hypothesis was disproved by Akbostanci et al. (2009) with respect to Turkey's income and CO2 emissions. Researchers found that the correlation between CO2 emissions and energy use produced inconsistent results.

Research from scientists like Pata (2017), Siddique et al. (2016), Jamel and Derbeli (2016), Studies by Jamel and Derbeli (2016) and Hummami and Saidi (2015) demonstrated that both energy consumption and CO2 emissions were harmful to the planet or positively cointegrated. However, Gokmenoglu and Sadeghieh (2019) and Zue et al. (2011) contend that energy use reduces CO2 emissions, which is good for the environment.

In contrast, conflicting results are found in studies on GDP growth, energy consumption, and how these factors influence the CO2 emissions. Growing GDP and power consumption positively influence CO2 emissions, according to research by authors like Munir and Khan (2010), Borhan et al. (2012), Kizilkaya (2017) and Smyth and Lean(2010).

In a similar vein, When Ali et al. (2016) examined the connection between Nigeria's GDP growth and energy use, and they discovered that both factors greatly raised CO2 emissions. However, energy consumption and GDP growth were found to have an adverse effect on CO2 emissions by Thao and Chon (2015). The bond among trade, energy use, and CO2 emissions was examined by Azam et al. (2016). The study found that the variables for the USA, Japan, China, and India demonstrated a significant cointegration. Poumanyvong and Kaneko (2010) also confirmed a statistically significant cointegration between energy consumption and CO2 emissions for the US, China, India, and Japan.

Despite studies being conducted to investigate the effects of many other macroeconomic factors, like the trade, industrialization, urbanization, and foreign direct investment (FDI), with association of power intake on CO2 emissions, private investment is found to be a missing variable in the literature. Hassan (2018) for Malaysia, Fu et al. (2014) for China, and Talukdar and Meisner (2001) for developing countries are a few studies that looked at how private investment affects the deterioration of the environment. Increased investment from individuals in nations that are developing reduces ecological breakdown (Meisner and Talukdar, 2001). For Malaysia, financial development and GDP growth were found to have negligible effects.

Variables Measurement

Abb.	**Variables**	**Definitions**	**Measurement Tool**	**Sources**
CO2	Carbon ioxide	By enabling businesses to purchase and sell emissions permits, CO2 emission trading is a market-based strategy for reducing carbon emissions.	CO2 emissions from gaseous fuel consumption (% of total)	The World Bank Database indicators
	Energy	Energy is the crucial component needed for a variety of economic		The World Bank

EN		activities, such as production, transportation, and consumption.	Energy use (kg of oil equivalent per capita)	Database indicators
GDP	Gross Domestic Product	GDP is a measure of an economy's overall health and growth that is used to evaluate, compare, and analyze the economic size and performance of other nations.	GDP per capita (constant 2015 US$)	The World Bank Database indicators
FD	Financial Development	Financial development is the expansion and enhancement of a nation's financial infrastructure, which includes banks, stock exchanges, and other organizations that are essential to the	Growth Gross capital formation	The World Bank Database indicators

		operation and expansion of the economy.		

Figure 2 above summarizes the body of research on the bond among CO2 emissions and the macroeconomic variables: GDP per capita (constant 2015 US dollars), growth, gross capital formation, and energy use (kg of oil equivalent per capita).

2.3.1 Across the nation research

Sachs, Peterson, and Panayotou (2000) examine the theory that the robustness of the EKC and environmental transition are driven by structural change over a long period of time, from 1870 to 1994. The data on export volumes, capital stock, population density, and GDP per capita from Maddison (1995) were used in the study. These data come from 17 participants of Japan, the United States, and the Organization for Economic Cooperation and Development (OECD) in the United Kingdom. Meanwhile, the Carbon Dioxide Information Analysis Center (CDIAC) of the Oak Ridge National Laboratory (ORNL) and the US energy division provide data on CO2 emissions. It is admirable that the correlation in serial form discovered by the Ordinary Least Squares (OLS) technique was corrected for using the Feasible Generalized Least Squares (FGLS) method.

The EKC connection, or an inverted U, was discovered for the panel data set by (Panayotou et al. 2000). Investigation indicates the shareholder base possesses a variable role. Emissions are influenced by capital stock, which rises in the initial phases of growth, ascends to be the nation industrializes, declines, then turns adverse within the highly developed industries era. people discovered as although buying and selling broadly results in higher emissions, it often leads to reduced emissions with elevated income levels. These results provide empirical support for the definition of EKC according to the developmental stages that the chosen test nations have experienced. Panayotou et al. (2000) discovered that

while higher population density raises CO2 emissions, these effects are not as significant as income effects.

Neumayer (2004) investigated the contributions of geographic variables to cross-national differences in CO2 emissions per capita. This is achieved by accounting for the GDP per capita's impact on CO2 emissions, as well as the impacts of hot and cold climates, the need for transportation, together with the availability of renewable power. An expansion of the Generalized Linear Model (GLM) methodology is the Generalized Estimating Equations (GEE) estimator was employed in the investigation's group evaluation of data, which covers 163 countries between 1960 and 1999. The sources of per capita GDP and CO2 emissions are the Penn World Table and the CDIAC at the US Department of Energy's ORNL. Climate data for the other variables are provided by the The World Bank, the Center for International Earth Science Information Network (CIESIN), and the World Resource Institute (WRI), in that order. Neumayer (2004) discovered an inverted U relationship (2000), which was in line with the findings of Panayotou et al. The study discovered that One warm-weather factor, the boiling point, did not show statistical relevance when geographic factors were taken into consideration. When both cold climate-specific factors are taken into account, CO2 emissions are found to increase on days with frost and to decrease on extremely cold days. CO2 emissions are positively correlated with the two measures of transportation demand: the total area impacted by human activity and the total length of road networks.

Clean growth was empirically supported by Neumayer's (2004) discovery that the proportion of energy derived from renewable sources reduces carbon dioxide emissions. In order to propose an alternative approach for estimating the EKC, Navin (2005) estimates the empirical models using parametric (Generalized Least Squares, or GLS, and Ordinary Least Squares, or OLS) and nonparametric (Nadarya-Watson kernel estimator) estimation techniques. The World Bank provides data on GDP per capita, carbon emissions, and other topics through its World Development Indicator (WDI) population density. Data on CO2 from the CDIAC at ORNL, the home of the US Department of Energy, is published by the WDI. The nonparametric method showed that the CO2 EKC's absence might not be reliable. This is because a decrease in CO2 emissions during periods of

high income is taken into account by the nonparametric estimation. This result validates the findings of Neumayer (2004) and Panayotou et al. (2000). The results of the parametric estimation show that the bond among income and CO2 emissions is best described by an N-shaped curve. The generalized EKC of Moomaw and Unruh (1997) is supported by this outcome. The inquiry's conclusions demonstrated that although income growth and CO2 emissions are negatively correlated, population density and emissions are positively correlated. The findings of Panayotou et al. (2000) about the connection between CO2 emissions and population density are corroborated by Navin (2005).

From 1995 to 2003, the countries of Eastern and Central Europe They cut their carbon dioxide emissions drastically. Zugravu, Millock, and Duchene (2008) addressed the question of whether this reduction in pollution is the result of more stringent environmental policy or just a lucky side effect of a significant economic transformation by using environmental stringency, or organizational effectiveness, and client choice for environmental quality, in a concurrently the formula model of the supply and demand (emissions) from contamination. Data on Emissions of carbon dioxide from industry are taken from the Joint Energy Program (IEA). Trade, GDP, and net per capita income are obtained from the World Bank's World Development Index (WDI); in the United Nations Industrial Development Organization (UNIDO) database, information on nine factories is arranged in accordance with their relative importance to global industrial production. This uneven surface dataset covering sixty nations were included in the analysis. Supply and demand theory was applied in the study's modeling, despite the fact that the EKC was not tested. Thus, Two Stage Least Squares (TSLS) is the optimal option for the estimation method in this paper. According to Zugravu et al. (2008), CO2 emissions increase in response to output growth and commerce. Positive trade is correlated with lower CO2 emissions, which partially supports the findings of Panayotou et al. (2000). The study's robustness tests showed that while democracy increases environmental policy stringency, trade openness decreases it. This demonstrates how institutional variables can be used to explain and forecast emissions reductions in the context of the "race to the bottom" theory.

Azomahou, Goedhuys, and Nguyen-Van (2009) use survey data from 107 countries and both parametric and nonparametric duties, much like Navin (2005)

between 1961 and 2004. Azomahou et al. (2009) employed data on, Gross capital formation (% of GDP) financial development, For calculating GDP per capita (constant 2015 US dollars) and primary power use per capita, the World Bank's WDI database was utilized; their results, however, contradict EKC. The regions and year dummies that were used were North America, Middle East, North Africa, South Asia, sub-Saharan Africa, Europe and Central Asia (as a reference), East Asia and the Pacific, and Latin America and the Caribbean. In order to account for changes in macroeconomic conditions and advancements in technology, dummies were used in the study. Azomahou et al. (2009) use the Generalized Additive Model (GAM) to Choose the not parametric operate over the parametric function (proportional model), and they use gain statistics to determine the importance of their economic modeling specification's non-linear behaviour. It was found that CO2 emissions are significantly decreased at high income levels and significantly increased at low income levels. They come to the conclusion that nations with greater GDPs have a better chance of succeeding in separating income from CO2 emissions. It was discovered that CO2 gases increase steadily increasing energy usage consumption. Nevertheless, the study offered no justification for its findings about the relationships between CO2 emissions and FDI, population density, trade openness, and net inflows of investments.

Grunewald and Martinez-Zarzoso (2009 evaluate the EKC theory in light of current environmental regulations (with reference by using a static and dynamic panel model to examine the CO2 driving factors in relation to the Kyoto Protocol and the Clean Development Mechanism (CDM). The United Nations Environment Programme (UNEP) and the United Nations Framework Convention on Climate Change (UNFCCC) both publish the total number of Climate Disclosure Mechanism (CDM) projects that a host country has completed the source of information on CO2 releases and ratification of Kyoto Protocol. Information with additional factors

is available from the World Bank's WDI, which covers 123 nations in an uneven panel between 1975 and 2004.

The empirical model of the study is analyzed using OLS and TSLS estimators. Their conclusions show that the Kyoto Protocol has reduced CO2 gases in nations that are established and growing. This agrees with what Carvalho and

Almeida (2010) found. Nonetheless, Martinez-Zarzoso and Grunewald (2009) were unable to find evidence of a reduction in gases due to the CDM variable. Furthermore, although the EKC for CO2 was confirmed for high-income countries, it could not be confirmed for all countries combined. This demonstrates that growing GDP is the main driver of rising emissions. A correlation was found by Grunewald and Martinez-Zarzoso (2009) between rising GDP manufacturing output and rising CO2 emissions. Furthermore, Poudel, et. al (2009) use a EKC for disposable income and CO2 in 15 Latin United States nations were estimated using semi-parametric and parameterized quadratic panel models. They achieve this by adding more explanatory variables, such as forestry acreage, population density, and illiteracy rate. All variables' data for the 21-year period 1980–2000 originated in the World Bank database, with the exception of illiteracy rate, which has no source mentioned, and acres used for forest products, which comes from a variety of references included in the appendix of the paper. After performing specification tests, Poudel et al. (2009) choose the semi-parametric estimate over the parameterized exponential connection., much like Azomahou et al. (2009) did. Robinson's kernel estimation method and the semiparametric one-way error component panel data model were employed.

The findings show that an N-shaped curve represents the relationship between CO2income and region. Every other variable is statistically insignificant. This supports the conclusion of Chapman and Agras (1999) that financial status has the biggest influence on CO2 emissions of all the explanatory variables examined. Carvalho and Almeida (2010) use an analysis of the Kyoto Protocol's global CO2 decrease regulations from 2000 to 2004 to explore the worldwide EKC theory. The study used a fixed effect model, spatial dependence, and OLS and FGLS to estimate its models. Their source for information regarding CO2 emissions and energy consumption is The US Department of Energy's Energy Information Administration (EIA) and the CDIAC provide data to the United Nations Statistics Division (UNSD).

Data pertaining to GDP per capita, ratification of The number concentration, trade intensity, and the Kyoto Protocol are sourced from the the World Bank, the International Monetary Fund (IMF), the Food and Agriculture Organization (FAO), as well as IEA, in that order. Carvalho and Almeida (2010)'s Statistical

findings indicate that there is an N-shaped EKC (which validates Navin (2005)) and that international agreements like the Kyoto Protocol may be important for reducing CO2 emissions. The study found a negative correlation between the number density and commerce volume, despite a positive bond among energy consumption and CO2 output. These results run counter to those of Navin (2005) and Panayotou et al. (2000). Compared to every other study that has been examined, the number of countries used in this study is inconsistently indicated. The paper's body and abstract make reference to 167 countries, whereas the appendix lists and discusses 187. As a result, there is inconsistent data reporting. Utilizing data from time series (1971–2006) for three countries, The EKC's presence and causal bonds with CO2 emissions links to trade openness and economic growth are examined by Choi, Heshmati, and Cho (2010). (Japan, a developed nation, Korea, a recently industrialized nation, and China, an emerging market). The task makes use of OLS. After determining In order the study makes use of Vector Automatic Regression (VAR), the Vector Error Correction Model (VECM) to test and the cointegration test developed by Johansen ascertain the immediate and ongoing connections between the determinants and CO2 emissions. Considered is the connection between GDP, openness, and CO2 emissions. The US Oak Ridge National Laboratory of the Department of Energy (ORNL), home of the Carbon Dioxide Information Analysis Centre (CDIAC), is the source of data on CO2 pollutants. Commerce willingness and true gross domestic product per person are sourced from the Penn World Table, the OECD repository of information, and the value added to green power are sourced from the per capita the use of oil and gas is sourced based on the analysis of BP data for global energy Choi et al. (2010) discovered the effects of atmosphere factors are heterogeneous, resulting in different outcomes for different countries and variables. In terms of EKC, China exhibits N-shaped curve, and Japan a reoriented N-shaped Korea has a cylindrical bend and. According to Choi et al. (2010), environmental the characteristics could deteriorate as China opens up to global commerce, trade openness and CO2 emissions do not statistically significantly correlate for greenhouse gas releases in Japan have expectation to fall as Korea opens up to engage in global trade. Using an overview of 213 nations from 1960 to 2009; Martinez-Zarzoso and Grunewald (2011) use the estimation of an evolving Panel information approach

utilizing the Generalized Method of Moments (GMM) and evaluate how CO2 emissions are affected by world climate legislation, in contrast to Grunewald and Martinez-Zarzoso (2009). The following prototype, which it relies upon EKC approach and A method for adjusting for heterogeneity in variables associated with policy is known as Stochastic Impacts on Population, Affluence, and Technology through Regression (STIRPAT) (CO2 emissions). Division of Power in the USA ORNL's CDIAC is the source of data on CO2 emissions, and the World Development Indicators (WDI) offer statistics regarding population and the GDP share of the manufacturing sector. The Kyoto Protocol may offer a means of reducing CO2 emissions, as Grunewald and Martinez-Zarzoso (2011) found. Countries that have achieved a pledge to cut their carbon footprint and ratified the Kyoto Protocol do so at a lower rate than comparable countries that did not, based on their long-term elasticity estimate. They also found that, while middle-class and low-income countries do not exhibit any signs of future emissions declining as income rises, some high-income countries have an inverted U relationship. Although the two studies vary with regard to it number of nations, time period, and scrutiny techniques used, the the outcomes are in the right direction those of Martinez-Zarzoso and Grunewald (2009).

Using the results jeßberger (2011) utilizing the modified U-shaped EKC and parametric theory illustrates the effect of the atmosphere on the growing quantity of Multilateral Environmental Agreements (MEAs) pertaining to CO2 emission projections through 2050. He used the UNEP clusterization of of MEAs, carbon footprint, and GDP per person values for 160 nations are included in the World Bank's WDI between 1960 and 2006. According to Jeßberger's (2011) findings, the quantity of MEAs related to the atmosphere fosters goodwill among international collaboration efforts aimed at lowering CO2 emissions to halt global warming. There is hope that global weather deals will lower the release of CO2, according to Martinez-Zarzoso and Grunewald (2009, 2011), Carvalho and Almeida (2010), and Jeßberger (2011), despite using distinct proxies (such as the Kyoto Protocol and MEA) and different estimation techniques to represent them. Using Arouri, Youssef, M'henni, and Rault (2012) build survey base root exams, collaboration methods, and panel Error Correction Models (ECM). examine the bond among power use, actual economic output, and CO2 emissions

for twelve countries in North Africa and the Middle East (MENA) between 1981 and 2005. The data mentioned earlier comes based on the World Bank WDI. The consequences they provide shows a quadratic relationship between the region's total real GDP and CO2 emissions. Carbon dioxide emissions are also increased by prolonged energy use. Their results show that none of the countries under investigation have the EKC officially validated at the national level, with the exception of Jordan. Even though Arouri et al. (2012) obtained a positive bond among electrical power and CO2 emissions, Azomahou et al. (2009), Carvalho and Almeida (2010) and contradict each other via locating an EKC. This is because each of them employed a distinct calculus techniques.

Pandelis (2012) uses the theory-based approach and the reduced-form approach, two distinct model approaches found in the literature, to investigate of the excellence of the research evidence supporting the existence regarding CO2 emissions EKC. 35 countries are included in an uneven group data collection that spans four time instances (1971–1975, 1976–1980, 1981–1985, and 1986–1990). Per capita CO2 emissions were provided by the CDIAC at ORNL, the US Department of Energy. GDP per person and additional control factors like trade accessibility and the amount of tangible assets held by every employee, investment, relative income, alternative measures of income, aggregate ages of education throughout a preceding a rise in population, the Gini ratio, the amount of broad debt of the nation as a percentage of GDP, and the last five years are derived in the Global Table at Penn. In order to take into consideration any the investigation uses TSLS to account for possible heterogeneity in the EKC model specification Pandelis (2012) used both approaches and came to the conclusion that the most common financial metrics are dependable variables influencing CO2 emissions, finding strong support for the EKC. This supports what Agras and Chapman (1999) said. The data does not provide strong support for the following: executive constraints, international trade (trade openness and investment), population growth rates, government debt as a percentage of GDP, average years spent in school over the previous five years, and other regressors. However, income and the Gini coefficient both remained significant in the explanation regarding emissions of CO2. This research's convincing endorsement of EKC validates the findings of Arouri et al. (2012) and Jeßberger

(2011), despite the fact that they used different estimation techniques, different variable vectors, and different study periods. However, the study's robust checks indicate that income with CO2 emissions showing an N-shaped correlation, which is in line with research from Poudel et al. (2009), Unruh and Moomaw (1997), Almeida and Carvalho (2010). Taguchi (2012) investigates the applicability of the revised EKC scenarios and the "race to the bottom" in Asia with regard to CO2 and SO2 emissions utilizing data collected via panels regarding 19 nations covering the years 1950–2009 and the GMM estimation technique. Stern's (2005) estimates of SO2 emissions and Boden, Marland, and Andres's (2011) estimates of CO2 emissions are used, respectively. The estimated CO2 data from CDIAC at ORNL, US Department of Energy, publishes Boden, Marland, and Andres (2011). Apart from GDP per capita, the level of revenue generation, in accordance with Taguchi (2012), correlates with extra factor. The research's proxy for revenue growth was a proportion regarding an economy's GDP each individual in terms of highest the GDP each person in the nations under study —that is, Japan's GDP per capita—for each year. His research indicates that while SO2 emissions follow the CO2 emissions increase when a person's earnings does, following the anticipated retracted U-shape. The updated EKC situation for SO2 emissions has been confirmed; however, there were no indications of the "race to the bottom" circumstances in which CO2 or emissions of SO2. The result validates what has been written assertion that local pollutants, like SO2, are more likely than global pollutants, to be covered by the EKC (CO2). Shafiee (2013), Tamazian and Rao (2010) and Gholami and who likewise employed using the GMM algorithm for estimation but with an alternative additional variable vector, are at odds with the study. Additionally, it validates the findings of Martinez-Zarzoso and Grunewald (2009, 2011), who were unable to determine the EKC for CO2 across all nations combined. However, given time frame of the study (60 years) as well as the limited quantity of countries included in the panel group, that investigation ought to be ongoing employed a different analyst for flexible boards rather than the GMM. As a result, the GMM findings could produce erroneous conventional mistakes (Roodman, 2009).

Using a dynamic panel model, Gholami and Shafiee (2013) analyze the EKC for the Organization of the Petroleum Exporting Countries (OPEC) using the GMM

estimation. For the years 1977–2004, data for every study variable was sourced provided by the WDI of the World Bank. Their findings indicate an N-shaped bond among income and emissions in the OPEC member countries. Results from Granados and Carpintero (2009), Almeida and Carvalho (2012) and, Poudel et al. (2009), Moomaw and Unruh (1997), and Pandelis (2012) concur with this It is found that every variable included within research, GDP per capita, energy, gross capital formation and the share of GDP added to manufactured goods—contributes significantly to CO2 emissions.

An disproportionate collection covering 26 OECD and 54 non-OECD nations is used by Liddle (2015) from 1971 to 2011 to get data on the population and income-related elasticity of carbon emissions STIRPAT and EKC were implemented in the investigation in modeling along using approximate techniques for the Common Correlated Effects (CMG) Mean Group and the Augmented Mean Group (AMG), just similar to Martinez-Zarzoso and Grunewald (2009, 2011).

The data used to calculate GDP per person, gross production of capital, and power all of which have as their foundation the World Development Indicators (WDI) of the world bank was obtained from Euromonitor International statistics. These chosen economies were examined for the years 1990–2012 using group irregular techniques such as Granger causality is acknowledged by Fully Modified Ordinary Least Squares (FMOLS) and the Vector Error Correction Model. Every variable is found to be cointegrated by the study. Despite CO2 emissions, GDP per capita, and energy, gross capital formation, the results show.

In a latest inquiry into the bond among CO2 emissions and GDP for 17 emerging markets for the years 1997–2014, Mitić, Ivanović, and Zdravković (2017) used FMOLS and DOLS. The study found that there was a steady-state bond as well as a long-run co-integration bond among the pair of factors. Even though in 2017, Mitić et al. failed to test for the EKC or account for any additional variables, their findings are consistent with those of Taguchi (2012) and Azomahou et al. (2009). Galor and Casey (2017), in contrast to Mitić et al. (2017), used the STIRPAT framework and included GDP per capita in addition to the total population, age distribution, and in terms of the general public that

lives within cities. Casey and Galor (2017) used a selection of 147 nations over the years 1950–2010 to find how each factor markedly rise in CO2 emissions. According to Liddle (2015) and Casey and Galor (2017), a population decrease could result in lower emissions and higher GDP per capita. Prior to delving into investigations that are specific to a nation regarding CO2 emissions and revenue growth, the previously examined research was tabulatedly summarized in.

Tamazian, Pinúiro, and Vadlamannati (2009) look into the connection among financial growth, economic growth, and CO2 emissions using group analysis for the economy of Brazil, Russia, India, and China, or BRICs spanning the years 1992–2004 The WDI of the World Bank offers analysis on oil and power intake, financial openness, GDP as a percentage of industrial output, and CO2 emissions. Gupta and Yuan (2008) offers details on the liberalization of finance. The market share of stocks traded split between earnings as well as a GDP proportion of the wealth of lenders to savings is provided by Beck et al. (2000) 2007 details modified. The UNSD provided the GDP split by the percentage of all power purchases, UNCTAD provided the stock of FDI inflows, and Chinn and Ito (2008) provided the capita account convertibility index.

Tamazian et al. (2009) findings illustrate this a decrease in per-person CO2 emissions is connected to a rise in FDI inflow. This also applies to deregulated finance, adaptability of capital accounts, and transparency. Conclusions that back up the EKC theory, which contends that while Air pollutants rise in tandem via a nation's development, that they begin to decline as revenue growth exceeds a certain threshold or tipping point. Without accounting for the control variables, Tamazian et al. (2009) examine the connection among environmental deterioration, finance, and economic growth. The results show that controlling for variables related to energy won't materially change the outcomes in the BRIC nations.

A similar study was conducted by Rao and Tamazian (2010), that considered the importance of institutional quality. They employed the Generalized Method of Moments (GMM) and Generalized Least Squares (GLS) estimation techniques to take endogeneity into account. This panel study from 1993 to 2004 looks at 24 nations that are developing from the Former Soviet Union (FSU) and Central and Eastern Europe (CEE). Trade, financial liberalization, trade liberalization,

trade liberalization and FOREX, FDI, price liberalization, institutional efficiency, energy consumption, and energy imports are among the variables that are taken into consideration. The origins of information these factors include the World Bank's WDI, the Chinn and Ito (2008) and the IMF's World Economic Outlook (WEO) are sources. The 2010 work by Rao and Tamazian findings bolster the EKC theory and highlight the relationship between fiscal growth and educational and sustainability. They discovered which monetary liberalization could have a negative impact on the state of the surroundings if it aren't implemented within a robust structure of institutions. Regarding the other hand, they discovered which increased FDI makes reduced CO2 emissions per person possible. CO2 emissions are impacted by trade, however, it impact is lessened when trade and institutional quality combine. In light of this discovery, it is seen that like (2008) Zugravu et al., Rao (2010), and Tamazian support the "race to bottom" claim made by Dasgupta et al. (2002).

These are the examination's conclusions conformity to Rao and Tamazian (2010), even though Tamazian et al. (2009) did not fully disclose in a view method. This is not implausible because similar model specifications and estimating techniques are used in both studies, even with some variable differences. Cost, costs of living, and the banking system liberalization.

Asghari (2013) looked into the relationship between economic and monetary expansion and greenhouse gas emissions in four countries around the Mediterranean from 1980 to 2011 using simultaneous equations. Financial development and These formulas figure out exogenous CO2 emissions per person. The factors to explicate taken into account during the research include trade, GDP per capita, energy gross capital formation. The panel information utilized here analysis comes from the World Bank's WDI. The outcomes demonstrate that the square of fiscal growth and GDP per person both enhance ecological state. As a result, The EKC is one thing, as well as a major contributor to reducing emissions of CO2 is financial development. While Tamazian et al. (2009) and Tamazian and Rao (2010) employed various forecasting procedures and fewer variables, Ashgari (2013) produced similar results.

Al-Mulali et al. (2015) looked at ninety-three nations between 1980 and 2008, breaking them down separated into four groups: sixteen poor nations twenty-six nations with comparatively low incomes (LMIC), twenty-six nations with higher to middle incomes (UMIC), and thirty-one nations with high incomes (HIC). Data on energy consumption are provided by the United States Energy data on ecological footprint are provided by the Global Footprint Network; the World Bank's WDI provides data on all other variables. Information Administration (EIA). Compared to LIC and LMIC, GDP expansion and environmental impact are higher in UMIC and HIC, exhibit an inverted U-shaped relationship, according to the fixed effects and GMM estimation results. The Writers pointed out that power use causes more surroundings harm at total revenue levels. The ecological footprint of urbanization and trade increases while that of LMICs, UMICs, and HICs decreases as a result of financial development. However, because LIC has lower levels of these variables than other income groups, they discovered that urbanization, trade, and monetary growth possess no discernible impact on the LIC's impact on the planet. The results (about HIC and UMIC) support the conclusions of Tamazian and Rao (2010), Asghari (2013), and Tamazian et al. (2009).

Salahuddin, Gow, and Ozturk (2015) investigate the bond among CO2 emissions and economic expansion in connection The monetary growth and electricity consumption of the Gulf Cooperation Council (GCC) countries between 1980 and 2012. Numerous econometric techniques were employed in the study, including Dynamic Fixed Effect Model (DFE), Fully Modified Ordinary Least Squares (FMOLS), and Dynamic Ordinary Least Squares (DOLS). The two measures that are used to simulate both monetary and economic growth are the real GDP per capita and the GDP share of domestic credit to the private sector. The data was given by the WDI. According to Salahuddin et al. (2015), there is a positive correlation between electricity consumption and economic growth and CO2 emissions, but a negative correlation between CO2 emissions and financial development. In other words, while economic growth and electricity consumption raise CO2 emissions, monetary growth lowers them. Salahuddin et al. (2015) did not test the EKC hypothesis, in contrast to other studies in this subsection, but their conclusion that financial development lowers CO2 emissions is consistent with Tamazian et al. (2009), Tamazian and Rao (2010),

Asghari (2013), and Al-Mulali et al. (2015). Before turning to national investigations on carbon dioxide emissions and financial and economic growth, the Appendix includes a tabular overview of the research that are covered during this the preceding sentence.

2.3.2 Country specific studies

He and Richard (2010) attempt to offer more trustworthy conclusions for the EKC hypothesis for Canada for the years 1948-2004 by using semi-parametric, flexible nonlinear parametric modelling techniques. The World Resources Institute (WRI) provides data on CO2 emissions per person. Statistics Canada is the source of every other data series, including GDP, crude oil price, industrial production as a percentage of GDP, oil exports as percentage of the whole exports, oil from abroad as a share of all purchases, and shipments into the United States. Two methods of estimation are used: the In part rectangular model and Gaussian kernel analyst (PLM). They discovered proof that the correlation among GDP per capita as well as CO2 emissions per person increased systematically. The aforementioned outcomes are compatible with (2009) Azomahou et al. They discovered that exports to the US, the proportion of oil exports to total exports, and industrial production as a percentage of GDP were all empirically significant contrasts. Although there is a negative correlation among CO2 emissions and the price of crude oil, there is a positive correlation among CO2 emissions and the percentage of oil imports in all imports and imports from the United States.

Vinesh and Boopen (2010) investigate the bond among GDP and CO2 emissions in Mauritius between 1975 and 2009. These two factors come from the World Bank's WDI and the US Department of Energy's ORNL's CDIAC. Additional research variables, including the population size, trade, secondary school enrolment ratio, investment divided by GDP, regulation variable, and the quantity of moving cars, which can also be acquired from the Workplace Data Institute. Vector Auto Regression (VAR) and Ordinary Least Squares (OLS) are the analytical methods used in this work. The findings they obtained showed that no inverted U-shape was formed. CO2 emissions have a negative correlation with the extracurricular activity proportion and controlling factor, but a positive

correlation with investment as determined by GDP, population, as well as the quantity of cars on the road. In contrast to researchers Poudel et al. (2009) and Pandelis (2012) did not discover any bond among CO2 emissions as well as supplementary attendance ratio, Boopen and Vinesh (2010) found a substantial negative bond among CO2 emissions and proficiency. It suggests that increased is the cause of Mauritius's lesser CO2 emissions.

Asghari (2012) investigates how different sources contributed to Iran's increased CO2 emissions from 1980 to 2011. These sources come from trade, GDP, energy, gross capital formation, and CO2 emissions, all of which are based on the WDI of the World Bank. She calculates an endogenously determined set of concurrent equations involving CO2 emissions and GDP per person using TSLS. As stated by the study, Iran's income and CO2 emissions have a U-shaped bond. According to the study's findings, trade As stated by initially reduce CO2 emissions until a certain regard, after who earn more money increases CO2 emissions.

The study's conclusions include the following: environmental degradation is more severe when institutions are weak; trade, GDP, energy, gross capital formation, and CO2 emissions, a favorable bond among CO2 emissions as well as environmental consciousness is higher in areas with higher population densities. The outcomes of Ogundipe and Alege (2013) regarding the connection between trade and CO2 emissions are in line with that of Onafowora and Owoye (2013). This contradiction may result from the different study periods that were used in the investigations. Urbanization and trade appear to increase CO2 emissions over time. This suggests that, in contrast to energy consumption, the detrimental the industry's consequences and urbanization on environmental quality in China take time to manifest. (2013) Owoye and Onafowora disagree with Li et al. (2016)'s finding that industry and China's CO2 emissions are negatively correlated.

Employing actual oil costs, Balaguer and Cantavella (2016) conduct an overview on the EKC as a proxy for changes in Spain's fossil fuels power use among 1874 and 2011. The correlations among Job growth and CO2 emissions, as well as global oil cost is estimated using the ARDL expert. Costs of natural gas were

derived originating via British Petroleum company's Statistical Review of World Energy, GDP was provided by Madison Historical Statistics, and CO2 emissions data came through the Carbon Dioxide Information Analysis of the US Department of Energy Centre (CDIAC). Cantavella and Balaguer (2016) discovered evidence supporting Spain's EKC the theory both in the both brief and lengthy term. Balaguer and Cantavella (2016) find evidence of EKC despite using the same estimation technique, validating the conclusions of Li et al. (2016). The findings from experimentation show that the explanation of Spain's CO2 emissions has an inverse relationship with changes in real oil prices over in the future. It makes sense using an analysis of AlMulali and Ozturk (2016), even though they made savings on cost of energy rather than oil cost.

According to Ajide and Oyinlola (2010), CO2 emissions per capita in Nigeria are correlated with GDP, the manufacturing GDP, FDI, traded stock value to GDP, and energy consumption percentages for the 1980–2008 years. The data came via the World Bank's file. Due to findings, income growth has less of an impact on CO2 emissions than monetary growth. The results show that the EKC is not a Nigerian citizen. Individuals discovered that FDI reduces CO2 emissions per person rise in proportion to GDP when the stock market's traded value rises. The study concludes that there is no meaningful correlation between the GDP share of the manufacturing sector and energy consumption. The study makes no mention of the estimation technique used. It finds that the bond among GDP and the stock market has a positive (as opposed to a adverse) impact on emissions of CO2, which contradicts Tamazian et al. (2009). However, it validates the findings of Tamazian and Rao (2010), Tamazian et al. (2009) who found a correlation between lower CO2 emissions and increased FDI inflow. Compared to Subsequent studies that used cointegration estimation techniques are more reliable than those Studies after Ajide and Oyinlola (2010), who omitted the calculation strategy, are not as trustworthy as those that employed cointegration estimation techniques. The effects of trade openness, urbanization, coal the impact of economic growth, fmonetary growth, and usage on CO2 emissions for South Africa between 1965 and 2008 were examined by Shahbaz, Tiwari, and Nasir (2011a). As techniques for estimation, The approaches to cointegration that are used are the Autoregressive Distributed Lag (ARDL) bounds testing

method and the Error Correction Model (ECM). Urbanization is the percentage of the population that lives in cities; fiscal growth is the amount of domestic credit available to each individual from the private sector. The information comes within the World Development Indicator (WDI) of the World Bank. The following research indicates that while growth in the economy raises CO2 emissions monetary growth decreases them. Empirical evidence, according to Shahbaz et al. (2011a), indicates that the use of coal greatly exacerbates environmental degradation, trade slows the growth of energy pollutants, and CO2 emissions increase in lockstep with urban population growth. Shahbaz, Tiwari, and Nasir (2011a) discovered that the EKC exists for South Africa, in contrast to Ajide and Oyinlola (2010) and Boopen and Vinesh (2010), who discovered that the EKC does not exist for Nigeria and Mauritius. For the years 1974–2009, Shahbaz, Islam, and Butt (2011b) look into the connections between Pakistan's CO2 emissions, financial development, economic growth, energy, and population expansion. Shahbaz (2013) and this study are comparable in that they use the same case study (Pakistan) and the same estimation technique (ARDL bounds testing approach to cointegration and ECM). They are not comparable to each other based on the same variables. Shahbaz et al. (2011b) employed real market capitalization as an indicator of financial development, whereas Shahbaz (2013) created and employed the index of financial instability. The World Bank's WDI is the source of the statistics. Pakistan's population growth, economic expansion, and energy consumption are the main contributors to CO2 emissions, according to Shahbaz et al. (2011b). The results verify that the EKC and financial development reduce Pakistan's emissions. Despite the different study period, Shahbaz's (2013) findings are supported by these results. Zhang (2011) investigated the bond among monetary growth and CO2 emissions in China over a sample period using the cointegration test, Granger causality test, Vector Error Correction Model (VECM), and variance decomposition. 1980–2009. Information about dependent variable CO2 emissions and the independent variable while GDP, energy and gross capital formation expressed are available from the WDI of World bank.

Zhang (2011) found that while China's financial development—particularly its scale of financial intermediation—acts as a significant driver for an increase in

CO2 emissions, CO2 emissions are most affected by minimal FDI. In contrast to Fiscal growth increases CO2 emissions, according to Zhang's (2011) research. Studies conducted in 2011a and 2011b by Shahbaz, Tiwari, and Nasir as well as Shahbaz, Islam, and Butt show how monetary growth lowers greenhouse gas emissions. It's possible that this is the result of the different appraisal techniques they used.

Tiwari, Shahbaz and Adnan, (2012a) investigate the connections between economic growth, power, Gross capital formation % of GDP, and CO2 emissions when it comes to South Africa using quarterly data spanning the years 1975–2011. Each and every piece of information came via the World Bank's WDI. Pollution Energy consumption (kg of equivalent oil per person) GDP per capita (constant 2015 US dollars), energy, and growth in the economy monetary growth and growth in the economy are simulated using real GDP per capita and domestic credit to the business community respectively. Based on empirical findings, trade and financial development are negatively impacted by energy consumption and economic growth, which lowers carbon emissions and improves the state of the planet.

These findings are comparable to those of Shahbaz, In addition to Shahbaz, Islam, and Butt, there is Pakistan and South Africa (2011b). Tiwari and Nasir (2011a) The existence of EKC in Indonesia has been reported by Shahbaz, Adnan, and Tiwari (2012a), Tiwari, Nasir, and Shahbaz (2011a); Shahbaz, Islam, and Butt (2011b). Emissions, economic expansion, energy efficiency, and financial development (calculated); in Portugal's case, by actual domestic financing from the private sector per capita. This work makes use of the Innovative Accounting Approach (IAA), both the VECM Granger Causality and the ARDL bounds testing method approach. The World Bank's WDI is the source of all analytical data. According to his research, CO2 emissions rise with economic expansion (as indicated by GDP per capita) and energy intensity, but they fall with financial development. It has been discovered that the relationship between amounts is an EKC or inverted U. These outcomes are listed below. The findings of Islam, Butt and Shahbaz, (2012a) for Indonesia and Shahbaz, Adnan, and Tiwari (2011b) for Pakistan and Pakistan, correspondingly meet.

The question of whether financial development regarding Malaysia lowers CO2 emissions was addressed by Shahbaz, Solarin, and Mahmood (2012b). They utilized VECM Granger causality to trade openness, GDP and electrical power per person, similarly, foreign direct investment, as well as domestic loans to the private sector per person for the years 1971–2008. Additionally, they used ARDL for the cointegration bounds testing method. This research employs the Innovative Accounting Approach (IAA). The World Bank's WDI is the source of the data. Their findings indicate that economic development, energy consumption, as well as foreign direct investment all help to reduce carbon emissions than did Ajide and Oyinlola's (2010) and Tamazian and Rao's (2010) findings. We demonstrate that it lowers per capita private sector CO2 emissions and environmental quality, but not household trust. Trade lowers emissions, according to Shahbaz, Solarin, and Mahmood (2012b), Tiwari, Shahbaz and Adnan, (2012a) and Shahbaz, Tiwari and Nasir (2011a).

In 2013, Boutabba carried out a study similar to the one mentioned above for India between 1970 and 2008. In this study, cointegration and VECM, the ARDL bounds testing procedure, are employed. Data on Based on WDI are measures of individual power use, real GDP, and CO2 emissions, and financial development (measured Gross capital formation (% of GDP). This finding validates the existence of EKC in India and bolsters Piaggio and Padilla's (2012) analysis of this nation. Additionally, this study indicates that per capita CO2 emissions rise in tandem with financial development, indicating that financial development speeds up environmental degradation. Similar estimating approaches were employed by Zhang (2011) and this study to corroborate their findings. Shahbaz (2013) employed a multivariate framework to evaluate the correlation between financial instability and carbon emissions from 1972 to 2009 using Pakistan as a case study. An approach to ARDL bounds testing was used in the study as the estimation method for cointegration and ECM. Data on real GDP per capita, power consumption per capita, trade, and CO2 emissions per capita are collected by the World Bank and used in the WDI. After that, the author develops an index of financial instability based on Loayza and Ranciere's (2006) research. The study found a positive bond among monetary instability and CO2 emissions. This implies that although Pakistan's environment benefits

from financial stability, It is not beneficial for financial volatility to rise. It also found that energy use is the primary source of CO2 emissions, that the EKC exists, and that there is an inverse relationship between commerce and CO2 emissions. Although all of these results support the conclusions of Shahbaz, Tiwari, and Nasir (2011a), they used different case studies (South Africa) and the same estimation techniques.

Charfeddine and Khediri (2016) investigate the following factors within the Emirates (UAE) from 1975 to 2011: trade, economic growth, trade, use of energy, and CO2 emissions urbanization (measured as a percentage of total population), fiscal growth (expressed to be a proportion of GDP by way of local loans to the private sector), and structural breaks and regime-switching. The WDI is the source of all of the variables. Charfeddine and Khediri (2016) found that monetary growth raises CO2 emissions in the case of the United Arab Emirates and confirms the existence of EKC by using the structural break procedure and VECM in conjunction with the Hatemi-J, Gregory, Hansen, and tests for cointegration. These results corroborate those of Zhang (2011) and Boutabba (2013). They found that the quality of the environment is influenced by trade, urbanization, and energy consumption. Therefore, in contrast to In contrast to Charfeddine and Khediri (2016) concluded that power usage reduces CO2 emissions, contrary to Salahuddin et al. (2015), whose work indicates that the GCC countries—which includes the UAE—have higher CO2 emissions due to electricity use.

Pakistan was studied from 1972 to 2013 by Javid and Sharif (2016). emphasizes the effects of monetary expansion Real The World Bank WDI is the source of data on per capita income, per capita energy consumption, per capita carbon emissions, and (measured as a percentage of GDP through domestic loans to the private sector). The model is estimated using the ARDL co-integration method. The existence of EKC in Pakistan has been established by Javid and Sharif (2016). They found a poor bond among monetary growth and environmental quality, and a strong correlation among carbon emissions and per capita energy use. Javid and Sharif (2016) corroborate the existence of EKC, Shahbaz, Islam, Butt (2011b), and Shahbaz (2013). However, earlier research by Zhang (2011), Boutabba (2013), Shahbaz, Islam, and Butt (2011b), Charfeddine and Khediri

(2016), and others on the bond among monetary growth and CO2 emissions, and Shahbaz (2013) are all in agreement with these findings. Unlike Shahbaz (2013), Javid and Sharif (2016) find no proof of a meaningful bond among Pakistan's emissions and trade openness features. Ozatac, Gokmenoglu, and Taspinar (2017) conducted a study examined Turkey's EKC from 1960 to 2013 and included the factors of energy consumption, GDP per capita (constant 2015 US$) and

Gross capital formation (% of GDP). ARDL technique was utilized in research similar to Shahbaz et al. (2011b) and Shahbaz (2013) to evaluate the premise that Turkey's financial development and EKC lower CO2 emissions. According to the report, raising city dwellers' knowledge is essential if urbanization is to have a beneficial effect on Turkey's carbon dioxide emissions.

CHAPTER III
METHODOLOY

3.0 Introduction

The current part of the study project attempts to offer a comprehensive explanation of all the various approaches, steps, as well as tactics involving taken so as to gather the necessary data for the investigation. This section also provides a detailed evaluation as well as an explanation about it various numerical techniques that one became accustomed to analyze the ancillary information obtained during the project.

The objective of the review will be to examine and assess the bond among South Africa's emissions of carbon dioxide (CO2) from 1990 to 2021 and (particular indicators of) financial and economic development. Empirical models are built in order to adequately explore the investigation's objectives. The ARDL is used as a national sample in this study, and econometric analysis methods are employed. The World Bank maintains the World Development Indicator (WDI) database supplied supplemental information over this investigation. With EVIEWS 12, the econometric analysis was carried out.

3.1 Sources and Types of Data

The bulk of research projects employ primary or secondary sources as their principal data sources. The latter option, in the author's opinion, is superior. The World Bank database is an open-source internet resource that the writers used to collect secondary data. He began his 33-year research assignment in South Africa in 1990 and it finished in 2021. Time series information for the entire year were acquired for the study. Some of the data sources reviewed in this analysis include energy impacts, GDP per capita, and gross capital formation, as well as the emissions of CO2 used as a proxy.

3.1.1 Data description and a prior expectation

Most research projects get their data from one of two primary sources: the primary source or secondary source. The latter option was preferable in the author's opinion. The author gathered secondary data using the World Bank Information the base, a publicly available web resource. The study's 31-year study period in South Africa ran from 1990 to 2021. For the study, annual time series data were gathered. To avoid having a very small amount of unbalanced time series data, Statistics are utilized to determine the study factors suitability and availability.

3.1.2 Descriptive Statistics

Numerical measurements referred to as statistical measurements that are used to list and describe the key characteristics. They give a succinct and understandable summary of the properties of the information. Metrics such as variance, standard deviation, mean, median, and mode minimum, and maximum are examples of common descriptive data. Based on the data, researchers and analysts can gain understanding and make wise conclusions with the aid of these statistics, which aid in understanding the central tendency, spread, and shape of the data distribution.

To simplify and make data easier to understand, descriptive statistics can be applied. It comprises elements such as the data's asymmetry or skewness, the mean, and the standard deviation, among others. Graphs can also be used to display descriptive statistics to help visualize the data's trends.

Table 1: Descriptive statistics

	CO2	ENERGY	GDP	GCF
Mean	1.367368	1941.555	5378.408	16.84944
Median	1.480306	2355.575	5583.527	16.72127
Maximum	2.382972	2904.276	6263.104	21.28725
Minimum	0.000000	0.000000	4269.700	12.40005
Std. Dev.	0.722672	1059.503	760.7546	1.935203
Skewness	-0.742935	-1.253475	-0.168319	-0.223754
Kurtosis	2.640125	2.739874	1.324736	3.066877
Jarque-Bera	3.116424	8.469957	3.893114	0.272981
Probability	0.210512	0.014480	0.142765	0.872415
Sum	43.75578	62129.76	172109.1	539.1821
Sum Sq. Dev.	16.18992	34798924	17941174	116.0953
Observations	32	32	32	32

3.2 Related Theories

Through the use of a study regarding time sequence, a consequences of power, economic, and monetary growth on pollution are examined. In this example, the time period studied was from 1990 to 2021 in South Africa. The following theories and ideas connected to my analysis were helpful:

EKC, or Environmental Kuznets Curve According to the EKC theory, there is an inverse U-shaped bond among environmental deterioration and expansion of the economy. Pollution rises initially when economies develop, but at a particular income level, environmental quality improves as a result of more awareness, technical development, and policy changes.

Decoupling the growth of the economy from energy use is referred to as energy-GDP decoupling. It indicates that economies may expand without

correspondingly increasing their energy consumption, which is frequently accomplished by increasing energy efficiency and implementing greener technology.

The pollution haven theory postulates that businesses may migrate to nations with laxer environmental restrictions in order to avoid strict pollution controls in their own nations. In host nations with inadequate rules, this may result in greater pollution.

Environmental Policy Stringency: The severity of environmental rules and regulations may have an impact on pollution levels. By placing higher regulations and penalties on polluting activity, stronger rules often reduce pollution.

Theory of Energy Transition: As a nation grows, this paradigm emphasizes the switch switching from fuels made from petroleum to green power. The rate and scope of this transformation are influenced by economic and financial considerations.

Technology Innovation and Adoption: Newer, cleaner energy sources and more effective manufacturing techniques can be developed and adopted as because of advances in technology, which will help to decrease pollution.

Environmental Awareness and Social Norms: Changing societal norms and raising environmental awareness can possess an effect on financial behavior and reduce pollution.

Financial Development and Making Eco-Friendly Innovation Investments: Financial growth along with spending money on green technology can help reduce pollution. Adoption of greener techniques can be accelerated by having access to funds for sustainable initiatives.

Links between commerce and the environment: As nations import and export commodities with various environmental footprints, trade can have an impact on pollution levels. Trade agreements and policies may have an effect on pollutant flows.

Policy Synergies and Interaction: Environmental, economic, and energy policy can combine to affect how pollution is produced. More sustainable development may result from the fusion of environmental protection and economic growth programs. You'll probably employ statistical techniques in your time series analysis to evaluate correlations, trends, and causal connections among power, economic indicators (such GDP), monetary growth measures, and pollution levels. It's crucial to take into account any confounding variables and apply the right methods to account for them. Furthermore, including pertinent policy modifications, technical developments, and outside variables (such global economic trends) will give a thorough knowledge of the dynamics at play. Remember that performing such an analysis necessitates having access to high-quality data as well as thorough assessment of the underlying assumptions of the methodology of choice.

3.2.1 Model Details

The model's bond among the independent variables energy, GDP per capita, and gross capital formation (% of GDP) over both the immediate and future the dependent variable CO2 emissions, total energy investment, and association tests of cooperativity are assessed with a distributed lag's assistance autoregressive model. I computed the integration. The explanatory factor is the amount of CO2 emissions per person. It serves as an alternative to emissions of greenhouse gases. This covers using fuels that are liquid, solid, or gaseous as well as gas flaring, which releases carbon dioxide into the atmosphere. Measurements are made in metric tons. The most prevalent greenhouse gas in the atmosphere is CO2. Because comparatively additional time series are accessible for numerous emerging nations than for any other pollutant, its data are particularly significant (Sek and Al-Sayed 2013, Roberts and Grimes 1997;). Thus, it's a decent substitute. One of the following variables serves as the explanatory variable:

3.3 Econometrics Model

3.3.1 Unit Root Analysis

If a time series is stable or not, it may be determined using a statistical technique known as a unit the root test. The variability and average of a stationary time series remain constant throughout its duration whereas a temporal sequence that is not stationary has a trend or another sort of variability that changes with time. The two most often applied the tests known as the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are unit roots. These assessments able to assess the legitimacy of an a moment sequence lacks stationarity and possesses a deterministic trend if it has a root system. Another possibility is the collection's static state, and the a sequence's unit root is the test's null hypothesis.

A serial correlation between these time series errors is handled differently through the PP and ADF investigations. The base unit examination must be passed by the ARDL model before it can be applied to any research project. It also establishes the data's stability. The unified root at any level or beginning difference needs to be deemed significant in statistics at 1%, 5%, or 10%. in order to use the ARDL model. This condition is applicable to any first deviation. To conduct the analysis, ARDL and ARDL integration tests were used. Thus, identifying the origins of oneness was the first step. To verify the findings and make sure the variables were correctly integrated, the Dickey-Fuller Generalized Least Squares (DLS), Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) models were employed.

Two distinct test cases had become accustomed to analyze unity routes:

The unchanging scenario and

i. The unchanging scenario and
ii. The evolving and trending scenario

In my research, the most common situation is a recurring alongside progress likely since it accounts for a range of modifications in addition to potential socio-political and political reasons that may have contributed to the variable changes. This helped to highlight the variables' stationarity and illustrate why.

3.3.1.1 Augmented Dickey-Fuller Test

To test their theory, A software application that can ascertain whether a variable has a unit root and is susceptible to an a priori random walk was developed and constructed by Dickey and Fuller in 1979. Hamilton (1994) offers four case studies to illustrate the extended Dickey-Fuller test's utility and applicability. The premise that the variable under study has a single unit root at each point in its distribution forms the basis of the null hypothesis. This is true regardless of the specific circumstance. Whether In order to determine whether a constant term and a temporal trend are included in the regression that builds the second technique, a drift term is added to the null hypothesis outcome measurement two primary areas of difference among the two strategies. if the null hypothesis contains a drift term or not depends on both of these variables. The sole difference between the method and the Dickey-Fuller test is that, unlike in the previous evaluation, it is applied to the model instead of the method.

3.3.2 Cointegration tests:

Cointegration Test are statistical tests used to determine if there are numerous connected, there is a long-run equilibrium for irregular time-varying factors. relationship, meaning they move together over time. These tests are essential when analyzing economic and financial data, where variables might not be stationary but have stable relationships in the long run.

One commonly used cointegration test is the Engle-Granger cointegration test. The procedure involves the following steps:

Test for Stationarity: Check if each individual the duration of the series is not moving. using procedures like the ADF stands for Augmented Dickey-Fuller test are used to find unit roots.

Form the Cointegrating Regression: Make an analysis if any of the individual series are not stationary equation using them.

Test for Cointegration: Apply tests like the test known as Augmented Engle-Granger (AEG) or the experiment of the co-integration of Johansen can be used to ascertain whether there is an ongoing connection among both variables.

The Johansen co-integration test is more powerful when dealing with multiple time series variables, as it can detect multiple cointegrating relationships simultaneously. It offers data regarding the quantity of cointegrating vectors and the corresponding coefficients, which helps in understanding the an ongoing connection between the different factors.

By using cointegration tests, researchers can determine whether the relationships between variables are spurious or in case one exists stable and meaningful enduring neutral connection between them.

3.3.3 ARDL Model

To investigate long-term relationships between variables, The ARDL (Autoregressive Distributed Lag) model, an econometric time series model, is applied. When working with non-stationary time series data, it is frequently utilized. This is the general appearance of the ARDL model.

Where: $Y(t) = \alpha + \sum(\beta\_i * Y(t-i)) + \sum(\gamma\_i * X(t-i)) + \varepsilon(t)$

The dependent variable at time t is represented by Y(t).

The independent variable at time t is represented by X(t).

The equation's constant term, or intercept, is denoted by α.

The coefficients of the lagged independent variable and dependent variable are, respectively, γ_i and β_i.

The error term at time t is represented by ε(t).

The ARDL model allows for examining several of the temporary changes through the lagged terms (β_i and γ_i) and long-term equilibrium relationships between the variables. details factors' sequence of incorporation determines the appropriate lag length and the cointegration properties between the variables. ARDL is particularly useful when dealing with data that exhibit different orders of integration.

3.3.1 ARDL Bound Test

In time series econometrics, the ARDL For (Auto Regressive Distributed Lag), the limit of the analysis is a statistical method used to determine if two or more variables have a long-term relationship with one another. When you suspect cointegration between these variables, it is very useful.

This is a brief explanation: ARDL Bound Examination: a statistical test that helps identify whether variables in a time series move in tandem over time by identifying whether they have a stable long-run link. If there is a link between the variables, this indicates that they are cointegrated and have a similar long-term trend. The bound test for ARDL is widely used in adopted econometrics to inspect the long-run correlations between economic variables while utilizing irregular periodical data.

3.3.2 ARDL Long Run Test

In time series econometrics, the occurrence as well as characteristics of a long-run connection between two or more variables are investigated using the ARDL (AutoRegressive Distributed Lag) Long-Run Test statistical technique. It assists in determining if these factors have a consistent and meaningful long-term connection with one another.

Here is a succinct explanation:

ARDL Long-Run Test: A statistical test that determines if variables in a time series have a stable, equilibrium relationship, suggesting that they move in unison over the long term. The cointegration concept, which denotes a common, enduring link between variables throughout time, is detected and examined using the ARDL Long-Run Test. When dealing with non-stationary time, the ARDL Long-Run Test is a useful tool in econometrics for comprehending the dynamics and interdependence of economic variables.

3.3.3 ARDL Short Run Test

In time series econometrics, a statistical method called the AutoRegressive Distributed Lag (ARDL) Temporary Test analyzing the short-term dynamics between two or more variables. Without taking into account a long-term equilibrium connection, it evaluates how changes in these variables impact each other during a very short period of time.

Here is a succinct explanation:

A statistical test known as the ARDL Short-Run Test concentrates on the interactions and short-term connections between variables in a time series. Without taking into account a long-term or equilibrium link, it examines the immediate impacts of changes in one variable on others. Understanding short-term dynamics and causal relationships between variables is made easier by the ARDL Short-Run Test. When studying how variables interact over the short term in econometrics, the ARDL Short-Run Test is particularly helpful since it sheds light on more direct cause-and-effect linkages.

3.3.4 Residual Diagnostics and Stability Test

By using a test called the residual diagnostic test, researchers can determine the reliability of the regression models and variables that are employed. Researchers can evaluate the accuracy of the models being utilized by using this test. To assess the reliability of the model that was used, more diagnostic tests are being used in this inquiry in addition to the ones that have previously been covered. The tests referred to as the autocorrelation test, residual normality test (serial correlation), and white (heteroskedasticity) test fall under this category. Heteroskedasticity is a sort of statistical analysis that is demonstrated by each of these tests. To find the degree Plot the residual values against the expected values and display the value of the residual values versus the projected values to determine the degree of autocorrelation among the data values. It is determined that heteroskedasticity exists in the model

by rejecting the null hypothesis and comparing the probability value with the computed F-statistics. To confirm the stability of the data, the CUSUM-square test was run in addition to the residual diagnostics test. The blue line on the graph represents data mobility, and the two red lines represent stability and the significant level at 5%. At the significance point where the blue line is positioned between the two red lines, the variables are stable of 5%.

3.3.5 Serial Correlation Lm Test

A statistical to determine whether serial correlation, also known as autocorrelation occasionally, residuals of a transformational equation. It is known as the Logistic Correlation LM (Lagrange Multiplier) Test or the LM test for autocorrelation. The premise of independence is broken by serial correlation, which happens when the error factors in a time series regression are connected with one another at various lags.

An overview using the LM Test for Serial Correlation is provided below:

The test looks for consistent patterns of correlation in the residuals of a regression model, which can be troublesome for the reliability of statistical judgments.

Procedure: Up to a predetermined number of lags, the LM test comprises regressing the estimated residuals from the initial regression model on their lagged values.

Serial linkage is not present in the residuals, which denotes that the error components are uncorrelated across observations and delays, is the test's null hypothesis. Other theories: An alternative theory proposes that the residuals include serial correlation. Test Statistic: The lagged residuals' ability to predict the present residuals is measured by the LM test statistic. If the test statistic differs considerably from zero, serial correlation may be present. Critical Values: against evaluate statistical significance, the test compares the LM test statistic against critical values derived from a chi-squared distribution. Interpretation:

Serial correlation is present in the residuals if there is statistical significance in the LM test statistic (i.e., above the critical value).

In certain circumstances, it can be required to resolve the problem by changing the model or applying different statistical methods. In econometrics and time series analysis, the Serial Correlation LM Test is a useful technique for identifying potential model specification problems and confirming the reliability of regression findings.

3.3.6 Heteroskedasticity test

To determine If the residuals' variance (the error terms) stays constant in a regression model across all values of the independent variables, a statistical test called the heteroskedasticity test, more precisely the Breusch-Pagan test or White test, is performed. It looks for heteroskedasticity, which is a condition where the variability of errors is not constant over the range of the predictors, in plainer terms.

An overview of a heteroskedasticity test is provided below:

A heteroskedasticity test's main goal is to determine if the homoskedasticity assumption has been broken. In contrast to heteroskedasticity, which suggests that the variance varies according to the values of the independent variables, homoskedasticity denotes the difference in the residuals is constant.

The investigation is commonly performed by fitting the fitted values of one or more independent variables to the squared leftovers generated by original regression model. If the variance of the residuals is unrelated to these factors, homoskedasticity is likely. However, heteroskedasticity is shown if the variance is linked to the independent variables.

Our test's null hypothesis is homoskedasticity, which states that the residual variance is constant at all levels of the independent variables.

Alternative Hypothesis: According to the alternative hypothesis, there is heteroskedasticity, which means that the residuals' variance is not constant.

Test Statistic: To ascertain if the variance of the residuals is substantially correlated with the independent variables, the heteroskedasticity test generates a test statistic, frequently an F-statistic or chi-squared statistic.

Critical Values: To determine statistical significance, the test compares the test statistic to critical values from an appropriate distribution (such as an F-distribution or chi-squared distribution).

Interpretation: Should the evaluation value surpass the crucial value and is statistically significant, heteroskedasticity is likely present. This shows that the constant error variance assumption is broken, which may compromise the validity of the regression results. In certain circumstances, model modifications may be required, such as the use of robust standard errors or the transformation of variables.

3.3.7 Stability Test

A evaluation of stability is an statistical process used to discover if the connection between variables in a model holds steady over time in the context of time series analysis or econometrics. Given that correlations between variables might alter as a result of many causes including policy changes, economic shocks, or structural shifts, it is especially pertinent when analyzing economic or financial data. A stability test may be explained in the following manner: Purpose: A stability test's main goal is to ascertain if a model's estimated relationships—which are frequently derived using historical data—remain constant throughout various time periods or subsamples. Procedure: The method for carrying out a stability test differs based on the particular situation and the kinds of relationships being looked at. Typical methods include: Recursive Stability Test: This entails using data from several time periods to estimate the model in a rolling or recursive manner. Over time, the consistency of coefficients or correlations is evaluated. The cumulative sum (CUSUM) test is used to identify associations that have changed over time. It entails visualizing the

residuals' cumulative sums and assessing if any trends or patterns are present. The Chow test determines if there is an information fundamental flaw, pointing to a change in connections, exists. The data must be divided into two or more subsamples, and the model parameters must be compared between subsamples. In a stability test, the null hypothesis is usually the presumption that the connection between the variables would remain constant or stable throughout time.

Alternative Hypothesis: The alternative hypothesis postulates that the relationships are unstable or have undergone structural change. Test Statistic: Various stability tests employ test statistics to evaluate the model's stability, including F-statistics, CUSUM statistics, and Chow test statistics.

Critical Values: against evaluate statistical significance, the test compares the test statistic against critical values derived from an appropriate distribution.

Interpretation:

The test statistic may indicate indications of instability or a structural change in the connections between variables over time if it is statistically significant, that is, if it surpasses the critical value. Investigating and accounting for the changes in such situations is crucial since the model's validity may be at risk. In particular when working with data that may be vulnerable to shifts or changes over time, stability tests are essential in ensuring that the results and conclusions generated from time series models are accurate. They aid researchers and analysts in locating structural flaws or instabilities in their models and accounting for them.

CHAPTER IV

Findings and Discussion

4.1 Introduction

Each of the four sections that make up present part contains an overview of the research's conclusions. Within the section that follows, the relationship between financial performance and changes to accounting and reporting in for-profit businesses is looked at and evaluated graphically. This essay's first section offers a thorough explanation of analyzing information and statistical interpretation. While the next section analyzes and talks about co-integration in the third section, which also covers the information collection's fixed examine. Co-integration is examined and discussed in the fourth session. Regression analysis, diagnostic tests, and methods to confirm whether the data or conclusions are stable are just a few of the subjects that will be covered in the final and concluding section. In spite of this, the testing was conducted in a manner consistent with the objectives of the investigation, and the experiment had been successfully finished using the EViews program.

4.2 Descriptive statistics

Table 1: Descriptive statistics

	CO2	ENERGY	GDP	GCF
Mean	1.367368	1941.555	5378.408	16.84944
Median	1.480306	2355.575	5583.527	16.72127
Maximum	2.382972	2904.276	6263.104	21.28725
Minimum	0.000000	0.000000	4269.700	12.40005
Std. Dev.	0.722672	1059.503	760.7546	1.935203
Skewness	-0.742935	-1.253475	-0.168319	-0.223754
Kurtosis	2.640125	2.739874	1.324736	3.066877
Jarque-Bera	3.116424	8.469957	3.893114	0.272981
Probability	0.210512	0.014480	0.142765	0.872415
Sum	43.75578	62129.76	172109.1	539.1821
Sum Sq. Dev.	16.18992	34798924	17941174	116.0953
Observations	32	32	32	32

Interpretation

The information you've given seems to be a compendium of statistics for four separate variables: CO2, ENERGY, GDP, and GCF (Gross Capital Formation). Various statistical metrics have been used to assess and summarize each variable. Let's dissect and explain each of these figures:

CO2 Emissions Mean (Average): The mean CO2 emissions are around 1.367368.
ENERGY: The average amount of energy used is about 1941.555.
Gross Domestic Product: The average GDP is around 5378.408.
GCF: The average Gross capital formation is at 16.84944 on average.
CO2 emissions: The median value for CO2 emissions is roughly 1.480306.
ENERGY: The average amount of energy used is about 2355.575.
Gross Domestic Product: The average GDP is around 5583.527.
Gross Capital Formation: The median value is 16.72127.
CO2 at its maximum (highest value)
2.382972 is the greatest amount of CO2 emissions ever logged in the data.
ENERGY: 2904.276 is the largest amount of energy ever tallied.
The highest GDP ever tallied is 6263.104.
The largest Gross Capital Formation ever observed was 21.28725.
Lowest (Minimum Value):
CO2: 0.000000 is the lowest CO2 emissions ever observed in the data.
ENERGY: The smallest amount of energy ever used was 0.000000.
GDP: 4269.700 is the lowest GDP ever tallied.
GCF: 12.40005 is the lowest Gross Capital Formation ever observed.
CO2 emissions have a standard deviation (also known as a measure of spread) of roughly 0.722672.
ENERGY: The average energy consumption standard deviation is 1059.503.
GDP: Roughly 760.7546 is the standard deviation of the GDP.
GCF: The gross capital formation standard deviation is around 1.935203.
Measure of Asymmetries: Skewness CO2:
The distribution has a little leftward (negative) skew, as seen by the negative skewness of CO2 emissions.

ENERGY: The usage of energy is negatively skewed.

GDP: GDP has a somewhat negative skewness.

Gross Capital Formation: The skewness of GCF is also somewhat negative.

(Measure of Data Peakness) Kurtosis

CO2 emissions have a positive kurtosis, which means that the distribution has somewhat heavier tails than a normal distribution.

Energy use has a somewhat positive kurtosis as well.

GDP: The GDP distribution has a positive kurtosis, which indicates a modest peak.

Gross Capital Formation: The kurtosis is quite high, indicating a distribution with long tails and a distinct peak.

Jarque-Bera test (test of normality):

This evaluate is employed to ascertain assuming the information is distributed normally. The p-values are quite high (higher than 0.05) for all variables, indicating of the fact the information does not deviate substantially according to a conventional circulation. Each variable's total value is reported, or sum.

Sum of Squared Deviations: For each variable, the sum of squared deviations from the mean is given.

32 observations, or data points, are available for each variable.

In conclusion, these statistics offer a thorough analysis of the four variables, including information on their central tendency, dispersion, skewness, kurtosis, and a test for normalcy. These statistics can help you learn more about the distribution and properties of the data.

The tables that follow display the unit root findings. the equation included the intercept and trend conditions during the unit root test, along with potential intercept results.

4.3 Table 2: Unit Root Test

Co2- ADF

Null Hypothesis: D(CO2) has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.888256	0.0000
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

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Interpretation

The Augmented Dickey-Fuller (ADF) trial, which is frequently used in econometrics to verify whether a chronology data set is unitary root based. connected to the result you've supplied. When a time series has a unit root, the data is non-stationary, which means it has a long-term trend and might not be appropriate for some types of statistical analysis. The results are explained as follows:

D(CO2) possesses a unitary root, that is the null conjecture (H0).

This is the theory being investigated. If the test findings indicate that we should reject this null hypothesis, then D(CO2) has neither a unit root nor an anchor point.

deterministic exogenous components:

The ADF test has "Constant" as an exogenous (deterministic) component.

The Schwartz Information Criterion (SIC) is used to automatically calculate the lag duration, with a maximum lag of 7 being taken into account. Since the lag duration in this instance was automatically set to 0, the model does not include any lagged values of D(CO2).

Dickey-Fuller test statistic with enhancements:

The statistic for the Augmented Dickey-Fuller test is -5.888256. The usage of this statistic determines whether or not time series data are stationary.
Critical Values for Tests:

To establish the statistical importance of the examination, the ADF test compares the test statistic to critical values in a variety of magnitudes (1%, 5%, and 10%). At the significance levels of 1%, 5%, and 10%, the test statistic of -5.888256 is below the critical values.

At these significance levels, the critical values are -2.621007, -2.963972, and -3.670170, in that order.
In the event that the test statistic is below the critical values, the null hypothesis might be rejected.

The test statistic in this case is substantially below the vital figures for relevance rates of 1%, 5%, and 10%, so you should eliminate the null theory. D(CO2) has no unit root and is stationary as a result. This shows that D(CO2) could be appropriate for some statistical analyses that make the assumption of stationarity.
In conclusion, the ADF test findings indicate that D(CO2) does not display a unit root and is steady after differencing, which is frequently a desired attribute for time series analysis.

Table 3: **Co2- PP**

Null Hypothesis: D(CO2) has a unit root
Exogenous: Constant
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.888256	0.0000
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

Interpretation

The Phillips-Perron (PP) To find out When a unit root is present in a set time sequence information, another statistical technique called the unit root test is utilized. and is non-stationary, is connected to the result you've supplied. The outcomes are comparable to those of the test known as Augmented Dickey-Fuller (ADF), and the following interpretation is given:
D(CO2) possesses a unit root, or the null theory (H0).
This is the theory being investigated. If the test findings indicate that we should reject this null hypothesis, then D(CO2) has neither a unit root nor a stationary point deterministic exogenous components:

The PP test includes "Constant" as an exogenous (deterministic) component. In order to account for any non-zero means in the time series data, a constant term is therefore introduced to the model.

Combining the Newey-West with a Bartlett kernel automated approach, the bandwidth is set to 0. The test's method of accounting for autocorrelation is dependent on the bandwidth parameter. It appears that an automated bandwidth selection mechanism was applied in this instance.
Statistics for the test of Phillips-Perron:

Based on the data, the Phillips-Perron test statistic is -5.888256. The usage of this statistic determines whether or not time series data are stationary.
Critical Values for Tests:

To establish the statistical significance the PP test, of the test compares the test figures to critical values at three distinct thresholds of relevance (1%, 5%, and 10%).
At the 1%, 5%, and 10% significance levels, the test statistic of -5.888256 is less than the critical values.
The critical values at these significance levels are, in that order, -2.621007, -2.963972, and -3.670170.

In the event that the test statistic is below the crucial levels, the null hypothesis can be rejected.

In summary:

In this instance, the test statistics are much below the crucial values at all three significance levels (1%, 5%, and 10%), hence you should reject the null hypothesis.

D(CO2) remains fixed and lacks a unit root, as shown by the Phillips-Perron test.

To sum up, the outcomes of Dickey-Fuller and Phillips-Perron enhanced tests indicate that D(CO2) remains stable even after differencing and does not exhibit a unit root.

A crucial element of time series analysis is stationarity.

Table 4: ENERGY- ADF

Null Hypothesis: D(ENERGY) has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.610926	0.0001
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

Interpretation:

In order to assess if a sequence of cases data set is not stationary as well as has a unit root; this test is known as the Augmented Dickey-Fuller (ADF) test. for the variable D(ENERGY) is utilized. The results are explained as follows:

The unit root of D(ENERGY) is the null hypothesis (H0).

This is the theory being investigated. If the test findings indicate that we should reject this null hypothesis, then D(ENERGY) is stationary and lacks a unit root.

deterministic exogenous components:

The ADF test has "Constant" as an exogenous (deterministic) component. In order to account for any non-zero means in the time series data, a constant term is therefore introduced to the model.

Long Lag:

One method is to use the Schwartz Information Criterion (SIC) automatically calculate the lag duration, with a maximum lag of 7 being taken into account. Since the automated process in this instance chose a lag duration of 0, the model does not include any delayed values of D(ENERGY).

Dickey-Fuller test statistic with enhancements:

The reported value for the Dickey-Fuller Augmented test statistic is -5.610926. The usage of this statistic determines whether or not time series data are stationary.

Critical Values for Tests:

To establish the statistical significance of the test, the ADF test compares three distinct significance levels (1%, 5%, and 10%) for the test statistic.

Interpretation:

At the 1%, 5%, and 10% significance stages, the procedure for testing parameter related to -5.610926 is less than the critical values.

The critical values at these levels of significance are, respectively, -3.670170, -2.963972, and -2.621007.

The result of the experiment may be denied if it is smaller than the null hypothesis crucial values.

Conclusion:

At each of the three significance levels (1%, 5%, and 10%), the test statistic in this instance is much lower than the crucial values.

You can infer from this that you should reject the null hypothesis.

According to the augmented Dickey-Fuller test, D(ENERGY) is stagnant and has no unit root at all.

In conclusion, the results of the Augmented Dickey-Fuller test indicate that D(ENERGY), upon differencing, does not show a unit root and is steady, which is a desired attribute for time series analysis.

Table 5: ENERGY – PP

Null Hypothesis: D(ENERGY) has a unit root
Exogenous: Constant
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.610926	0.0001
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

Interpretation

In order to assess if an irregular time series data set has a unit root, a method known as the unit root test of Phillips-Perron (PP) to determine variable D(ENERGY) is utilized. The result you've supplied relates to this test. The following is how the findings are interpreted:
The unit root of D(ENERGY) is the null hypothesis (H0).

This is the theory being investigated. If the test findings indicate that we should reject this null hypothesis, then D(ENERGY) is stationary and lacks a unit root. deterministic exogenous components:

The PP test includes "Constant" as an exogenous (deterministic) component. In order to account for any non-zero means in the time series data, a constant term is therefore introduced to the model.
Bandwidth:

With the Newey-West and a Bartlett kernel automated approach, the bandwidth is set to 0. The test's method of accounting for autocorrelation is dependent on the bandwidth parameter. It appears that an automated bandwidth selection mechanism was applied in this instance.

Statistics for the test of Phillips-Perron:

According to the data, the test of Phillips-Perron statistic is -5.610926. The usage of this statistic determines whether or not time series data are stationary.

Critical Values for Tests:

To establish a numerical importance of the PP test, compares the test statistic to critical values at three distinct magnitudes (1%, 5%, and 10%).

At the 1%, 5%, and 10% significance levels, the test statistic of -5.610926 is less than the critical values.

The critical values at these levels of significance are, respectively, -3.670170, -2.963972, and -2.621007.

If the test statistic is smaller than the assumption that, it might be rejected crucial values.

Conclusion:

At each of the three significance levels (1%, 5%, and 10%), the test statistic in this instance is much lower than the crucial values.

You can infer from this that you should reject the null hypothesis.

The Phillips-Perron test shows that D(ENERGY) has neither a unit root nor a point of stagnation

In conclusion, the results of the Phillips-Perron test indicate that D(ENERGY) does not display a unit root and is steady after differencing, which is a desired attribute for time series analysis.

These outcomes are in agreement with the Dickey-Fuller Augmented (ADF) test you previously supplied.

Table 6: GDP – ADF

Null Hypothesis: D(GDP) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.106850	0.0034
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

Interpretation

In order to evaluate if a time series data set has a unit root and is non-stationary, a technique called the Augmented Dickey-Fuller (ADF) test for the variable D(GDP) is utilized. The results are explained as follows:

D(GDP) has a unit root, which is the null hypothesis (H0).

This is the theory being investigated. If the test findings indicate that we should reject this null hypothesis, then D(GDP) is stable and does not have a unit root. deterministic exogenous components:

The ADF test has "Constant" as an exogenous (deterministic) component. In order to account for any non-zero means in the time series data, a constant term is therefore introduced to the model.
Long Lag:

The Schwartz Information Criterion (SIC) is used to automatically calculate the lag duration, with a maximum lag of 7 being taken into account. Since the automated process in this instance chose a lag duration of 0, the model does not include any delayed values of D(GDP).

Dickey-Fuller test statistic with enhancements:

The reported value for the Augmented Dickey-Fuller test statistic is -4.106850. The usage of this statistic determines whether or not time series data are stationary.

Critical Values for Tests:

To establish the statistical significance of the test, the ADF test compares the test statistic to critical values at each of the three magnitudes (1%, 5%, and 10%).

The test statistic of -4.106850 is less than the crucial values at the 1% significance level (-3.670170), but not at the 5% and 10% significance levels (-2.963972 and -2.621007, respectively).

Conclusion:

You can draw the conclusion that you should reject the null hypothesis at the 1% degree of importance.

The test statistic is not substantially lower compared to the essential factors, though, at the 5% and 10% significance levels.

Generally Speaking:

The most cautious approach to ADF test results interpretation is to take the 1% significance threshold into account. You should deny the idea that nothing exists. test statistic at this level is far below the crucial value.

The Augmented Dickey-Fuller test at the 1% significance level indicates that D(GDP) is stable and does not have a unit root.

In conclusion, the ADF test findings point to D(GDP) being stable and lacking a unit root after differencing, especially at the 1% significance level. An essential component of time series analysis is stationarity.

Table 7: GDP – PP

Null Hypothesis: D(GDP) has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.069880	0.0037
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

Interpretation

In order to evaluate if a time series data set has a unit root and is non-stationary, a method known as the Phillips-Perron (PP) unit root test for the variable D(GDP) is utilized. The result you've supplied relates to this test. The results are explained as follows:

D(GDP) has a unit root, which is the null hypothesis (H0).

This is the theory being investigated. If the test findings indicate that we should reject this null hypothesis, then D(GDP) is stable and does not have a unit root. deterministic exogenous components:

The PP test includes "Constant" as an exogenous (deterministic) component. In order to account for any non-zero means in the time series data, a constant term is therefore introduced to the model.
Bandwidth:

The bandwidth is set to 1, and a Bartlett kernel and the Newey-West automated technique are employed. The test's method of accounting for autocorrelation is

dependent on the bandwidth parameter. It appears that a specific bandwidth value of 1 was selected in this instance.

Statistics for the Phillips-Perron Test:

As per the data, the Phillips-Perron examination statistic is -4.069880. The usage of this statistic determines whether or not time series data are stationary.

Critical Values for Tests:

To establish the statistical significance, the PP test compares the test numerical data to the required percentages (1%, 5%, and 10%) at three different levels of significance.

The test statistic of -4.069880 is less than the critical values at the 1% significance level (-3.670170), but not less than the significant values at the 5% and 10% significance levels (-2.621007 and -2.963972, accordingly).

Conclusion:

You can draw the conclusion that you should reject the null hypothesis at the 1% degree of importance.

The measurement metric is not substantially lower compared to the essential factors, though, at the 5% and 10% significance levels.

Generally Speaking:

The most cautious method to evaluating PP test findings is to take the 1% significance threshold into account. You should reject the null hypothesis since the test statistic at this level is far below the crucial value.

Therefore, the Phillips-Perron test at the 1% significance level indicates that D(GDP) is stable and does not have a unit root.

In conclusion, the Phillips-Perron test results point to D(GDP) being stable and not showing a unit root after differencing, especially at the 1% significance level. A crucial aspect of time series analysis is stationarity. These outcomes are in agreement with the Augmented Dickey-Fuller (ADF) test you previously supplied.

Table 8: GCF – ADF

Null Hypothesis: D(GCF) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.130308	0.0002
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

Interpretation

In order to assess if a time series data set has a unit root and is non-stationary, a test called the Augmented Dickey-Fuller (ADF) test for the variable D(GCF) is utilized. The results are explained as follows:

D(GCF) has a unit root, which is the null hypothesis (H0).

This is the theory being investigated. If the test findings indicate that we should reject this null hypothesis, then D(GCF) is stationary and does not have a unit root.
deterministic exogenous components:

The ADF test has "Constant" as an exogenous (deterministic) component. In order to account for any non-zero means in the time series data, a constant term is therefore introduced to the model.
Long Lag:

The Schwartz Information Criterion (SIC) is used to automatically calculate the lag duration, with a maximum lag of 7 being taken into account. Since the

automated process in this instance chose a lag duration of 0, the model does not contain any lagged values of D(GCF).

Dickey-Fuller test statistic with enhancements:

The reported value for the Augmented Dickey-Fuller test statistic is -5.130308. The usage of this statistic determines whether or not time series data are stationary.

Critical Values for Tests:

To establish the statistical significance of the test, the ADF test compares the test statistic to critical values at three distinct levels of significance (1%, 5%, and 10%).

Interpretation:

At the 1%, 5%, and 10% significance levels, the test statistic of -5.130308 is less than the critical values.

The critical values at these levels of significance are, respectively, -3.670170, -2.963972, and -2.621007.

The null hypothesis can be rejected if the test statistic is smaller than the crucial values.

Conclusion:

At each of the three significance levels (1%, 5%, and 10%), the test statistic in this instance is much lower than the crucial values.

You can infer from this that you should reject the null hypothesis.

The Augmented Dickey-Fuller test shows that D(GCF) is stationary and does not have a unit root.

According to the ADF test findings, D(GCF) does not display a unit root and is steady after differencing, which is a desired characteristic for time series analysis.

Table 9: GCF – PP

Null Hypothesis: D(GCF) has a unit root

Exogenous: Constant

Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.117676	0.0002
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

Interpretation

The output you gave relates to the Phillips-Perron (PP) unit root test for the variable D(GCF), which is employed to ascertain if a time series data set has a unit root and is non-stationary. The results are explained as follows:

H0, the null hypothesis It has a unit root, D(GCF). This is the theory being investigated. If the test findings indicate that we should reject this null hypothesis, then D(GCF) is stationary and does not have a unit root.

deterministic exogenous components: The PP test includes "Constant" as an exogenous (deterministic) component. In order to account for any non-zero means in the time series data, a constant term is therefore introduced to the model.

Bandwidth: The bandwidth is set to 4, and a Bartlett kernel is used with the Newey-West automated technique. The test's method of accounting for autocorrelation is dependent on the bandwidth parameter. It appears that a specific bandwidth value of 4 was selected in this instance.

Statistics for the Phillips-Perron Test: According to the data, the Phillips-Perron test statistic is -5.117676. The usage of this statistic determines whether or not time series data are stationary.

Test Critical Values: To establish the statistical significance, the PP test compares the test statistic to critical values at three distinct levels of significance (1%, 5%, and 10%).

Interpretation:

At the 1%, 5%, and 10% significance levels, the test statistic of -5.117676 is less than the critical values.

The critical values at these levels of significance are, respectively, -3.670170, -2.963972, and -2.621007.

If the test statistic is less than the null hypothesis, it might be disregarded crucial values.

Conclusion: At all three significance levels (1%, 5%, and 10%), the test statistic in this instance is much lower than the crucial values.

You can infer from this that you should reject the null hypothesis.

As a result, the Phillips-Perron test shows that D(GCF) is stationary and does not possess a unit root.

In conclusion, the findings of the Phillips-Perron test indicate that D(GCF) is steady and does not show a unit root after differencing, which is a desired characteristic for time series analysis. These outcomes are in agreement with the Augmented Dickey-Fuller (ADF) test you previously supplied.

4.4 Table 10: ARDL Bound Test

F-Bounds Test		Null Hypothesis: No levels relations		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	7.596672	10%	2.72	3.77
K	3	5%	3.23	4.35
		2.5%	3.69	4.89
		1%	4.29	5.61

Interpretation

To determine whether there is evidence of a correlation connection between variables, utilize the F-Bounds Test. Even though the individual variables in

cointegration may not be stationary, their linear combination may be. This suggests that the variables have been related throughout time. Here is how to interpret the results of the F-Bounds Test:

Null Hypothesis: No link between the levels

This is the theory being investigated. It suggests that there is evidence of a cointegration bond among the variables, indicating a long-term association, if the test findings imply we should reject this null hypothesis.
Test Statistics and Levels of Significance

It is said that the test statistic is 7.596672.
There are significance thresholds of 10%, 5%, 2.5%, and 1%.
Interpretation:

Depending on the in terms of importance, the F-statistic is compared to the crucial values to decide whether or not Rejecting the null hypothesis is appropriate. If the F-statistic is greater than the critical value, the null hypothesis is accepted at the relevance degree.
Conclusion:

In this instance, the 10%, 5%, 2.5%, and 1% significance levels are used to compare the F-statistic to the critical values.
At each of the significance levels listed in the table, the F-statistic of 7.596672 is higher than the critical values.
As a result, you would come to the conclusion that you should reject the null hypothesis of "No levels relationship."
Inferring a long-term link or association between the variables being examined, this shows that there is evidence of a cointegration relationship amongst them.
In conclusion, the findings of the F-Bounds Test point to evidence of a cointegration connection between the variables under investigation, pointing to a long-term link or correlation between them. This discovery may be significant for specific time series analysis and modeling techniques.

4.4.1 Table 11: ARDL Long Test

Levels Equation

Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ENERGY	0.000563	7.27E-05	7.740382	0.0000
GDP	0.000282	6.49E-05	4.351589	0.0014
GCF	0.112058	0.028561	3.923487	0.0029

EC = CO2 - (0.0006*ENERGY + 0.0003*GDP + 0.1121*GCF)

Interpretation

You are regressing a dependent variable (EC, which seems to reflect some variable) on three independent variables (ENERGY, GDP, and GCF) in the equation you have supplied, which looks to be a levels equation. The equation and the estimated coefficients should be interpreted as follows:

EC = CO2 - (0.0006 * ENERGY * 0.0003 * GDP * 0.1121 * GCF)

Estimates of the coefficients: interpretation

Energy: The energy coefficient is 0.000563. This indicates that the dependent variable EC is anticipated to rise by 0.000563 units for each unit increase in ENERGY, maintaining other variables fixed. This coefficient is statistically significant at a very low p-value (p 0.0001), according to the t-statistic of 7.740382, indicating that ENERGY significantly affects EC. GDP

GDP has a coefficient of 0.000282. The dependent variable EC is anticipated to rise by 0.000282 units for every unit increase in GDP, holding other variables constant. Although the significance threshold for this coefficient is not as low as that for ENERGY, the t-statistic of 4.351589 suggests that it is statistically significant (p = 0.0014).

GCF: GCF's coefficient is 0.112058. The dependent variable EC is anticipated to rise by 0.112058 units for every unit increase in GCF while holding other variables constant. This coefficient is statistically significant, as shown by the t-statistic of 3.923487 (p = 0.0029), which implies that GCF also significantly affects EC.

Generally Speaking:

According to the equation, the variables CO2, ENERGY, GDP, and GCF determine the variable EC.

ENERGY, followed by GDP and GCF, seems to have the most effect on EC.

It's vital to highlight that this interpretation depends on the dependent and independent variables having a linear relationship. Furthermore, although it doesn't always suggest causality, the statistical significance of the coefficients shows that these associations are unlikely to have arisen by coincidence. The coefficients indicate, while holding other factors constant, the predicted changes in EC linked to variations in the corresponding independent variables.

4.4.2 Table 12: ARDL Short run Test

ARDL Error Correction Regression

Dependent Variable: D(CO2)

Selected Model: ARDL(2, 5, 5, 1)

Case 3: Unrestricted Constant and No Trend

Date: 09/17/23 Time: 00:01

Sample: 1990 2021

Included observations: 27

ECM Regression
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-5.683222	0.901384	-6.304995	0.0001
D(CO2(-1))	0.334615	0.169562	1.973410	0.0767
D(ENERGY)	-0.000172	7.14E-05	-2.405873	0.0369
D(ENERGY(-1))	-0.001194	0.000198	-6.033973	0.0001
D(ENERGY(-2))	-0.000376	0.000211	-1.779356	0.1055
D(ENERGY(-3))	3.17E-05	0.000138	0.229431	0.8232
D(ENERGY(-4))	0.000247	8.18E-05	3.023645	0.0128
D(GDP)	0.000983	0.000401	2.455110	0.0340
D(GDP(-1))	-0.000310	0.000329	-0.940047	0.3693
D(GDP(-2))	-0.000645	0.000533	-1.210543	0.2539
D(GDP(-3))	-0.001270	0.000496	-2.560364	0.0284
D(GDP(-4))	-0.001029	0.000489	-2.105474	0.0615
D(GCF)	0.059289	0.047137	1.257786	0.2370
CointEq(-1)*	-1.792615	0.285216	-6.285117	0.0001

R-squared	0.946447	Mean dependent var	-0.057719
Adjusted R-squared	0.892894	S.D. dependent var	0.539131
S.E. of regression	0.176442	Akaike info criterion	-0.325501
Sum squared resid	0.404713	Schwarz criterion	0.346414
Log likelihood	18.39426	Hannan-Quinn criter.	-0.125705
F-statistic	17.67307	Durbin-Watson stat	2.190411
Prob(F-statistic)	0.000004		

Interpretation

An ARDL (AutoRegressive Distributed Lag) error correction model estimation produced the results you presented. When cointegration may be present, this kind of model is frequently employed to examine connections among time series data. Let's analyze the outcomes:

ECM Regression: The results of the error correction model (ECM) regression, which generally represents both the short-run dynamics and the long-run equilibrium connection between the variables, are shown in this area of the output.

C (Constant): The constant term's coefficient is -5.683222. When all other independent variables are equal to zero, this shows the short-term effect on the dependent variable D(CO2). Statistically speaking, it is significant (p-value 0.0001).

D(CO2(-1)): The lagged value of D(CO2) has a coefficient of 0.334615.

This shows the short-term effects of the delayed CO2 change on the present CO2 change. It is statistically insignificant to a little degree (p-value = 0.0767).

D(ENERGY): D(ENERGY) has a coefficient of -0.000172. This shows the immediate effect of a one-unit change in energy on a change in carbon dioxide. (p-value = 0.0369) It is statistically significant.

D(ENERGY(-1)) and other concepts with lags The short-term effects of lagging changes in ENERGY on changes in CO2 in earlier eras are shown by these coefficients. The statistical significance of several of these phrases varies from term to term.

D(GDP): D(GDP) has a coefficient of 0.000983. This shows the immediate effects of a one-unit change in GDP on a change in CO2 levels. (p-value = 0.0340) It is statistically significant.

D(GCF): The D(GCF) coefficient is 0.059289. This is an illustration of the immediate effects of a one-unit change in GCF on a change in CO2. (p-value = 0.2370) It is not statistically significant.

CointEq(-1)*: The delayed error correction term is represented by this term. As it gauges the speed at which the long-term equilibrium is being adjusted., it is a

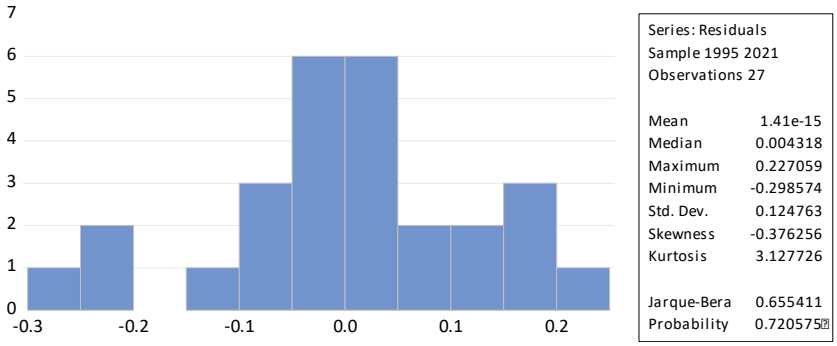
crucial component of the ECM. The model appears to swiftly rectify departures from the long-run equilibrium, according to a substantial negative coefficient.
Suitable for:

R-squared: A measure of the way the simulation matches the data, the R-squared value is 0.946447. It suggests that a substantial portion of the dependent variable's variance D(CO2) is explained by the model.
R-squared adjusted: The number of independent variables is taken into consideration in the adjusted R-squared value in the model, is 0.892894.
REGRESSION S.E. This indicates the regression's standard error, which gauges the typical mistake in the predictions made by the model.
F-statistic: The F-statistic assesses the overall significance of the model. The overall statistical significance of the model is shown by a small p-value (0.000004).
Durbin-Watson statistic: The Durbin-Watson statistic examines the residuals for autocorrelation. A result of 2.190411 indicates the possibility of autocorrelation.
Conclusion:

According to the ECM regression, variations in ENERGY, GDP, lagged values of CO2 and GDP, and CO2 variations all have statistically significant short-run effects on variations in GDP and GDP.
It is clear from the CointEq(-1)* term's significance and negative sign that the model responds swiftly to changes from the long-run equilibrium.
Some factors don't seem to have statistically significant short-run effects on the change in CO2, including D(ENERGY(-2)), D(ENERGY(-3)), D(GCF), and D(GDP(-2).
The model's total R-squared value is strong, indicating that it fits the data well.
Please be aware that how these results are interpreted relies on the precise context and subject area of your study, and that more investigation may be required to reach significant conclusions regarding the correlations between the variables.

4.5 Table 13: Residual Diagnostics Test

Normality Test



4.6 Table 14: Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:

Null hypothesis: No serial correlation at up to 1 lag

F-statistic	0.535673	Prob. F(1,9)	0.4829
Obs*R-squared	1.516742	Prob. Chi-Square(1)	0.2181

Interpretation:

If serial correlation (autocorrelation), particularly up to a certain number of lags, is present in the residuals of a regression model, it can be detected using the Breusch-Godfrey Serial Correlation LM Test. In your case, the null hypothesis is that there is no serial correlation with a latency of up to one. The test findings should be interpreted as follows:

The F-statistic is 0.535673, according to the data. The null hypothesis that there is no serial association is tested using this statistic. In this instance, it checks for serial correlation up to 1 lag.

Prob. F(1,9): The F-statistic's p-value is represented by this number. It reveals the likelihood of coming across an F-statistic that is as severe as the one determined using the null hypothesis.
Obs*R-squared: 1.516742 is the observed R-squared value. In the Breusch-Godfrey test, this statistic is connected to the sum of squared residuals.
Chi-Square(1) probability: This is the p-value for the chi-squared statistic, which is an additional method for evaluating serial correlation.
Interpretation:

The chi-squared statistic's p-value in your findings is 0.2181 and the F-statistic's p-value is 0.4829.
Usually, to decide whether to reject the null hypothesis in hypothesis testing, you compare the p-value to a significance threshold (like 0.05).
Both of the p-values in this instance, 0.4829 and 0.2181, are higher than typical significance levels (such as 0.05).
P-values above the significance level indicate that there is insufficient evidence to reject the null hypothesis.

Conclusion:

You would typically draw the conclusion that there is not enough evidence to reject the null hypothesis based on the p-values supplied in your results.
This suggests that you lack solid statistical support for your claim that serial correlation exists at lags up to one in your regression model's residuals.
Remember that the interpretation may change based on the particular context of your study, the lag order you select, and the significance level you employ. If serial correlation is a problem, you may think about checking for it at longer delays or looking at different models to solve the problem.

4.7 Table 15: Heteroskedasticity Test

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	1.074403	Prob. F(16,10)	0.4686
Obs*R-squared	17.07004	Prob. Chi-Square(16)	0.3811

Interpretation

The Breusch-Pagan-Godfrey test, which is used to determine whether heteroskedasticity (unequal variances of the error terms) is present in a regression model, is the heteroskedasticity test you've carried out. This test's null hypothesis is homoskedasticity, which states that the error variances are constant for all observations. The test findings should be interpreted as follows:

F-statistic: 1.074403 is the F-statistic. The homoskedasticity null hypothesis is tested using this statistic.
Prob. F(16,10): The F-statistic's p-value is represented by this number. It reveals the likelihood of coming across an F-statistic that is as severe as the one determined using the null hypothesis.
Obs*R-squared: R-squared as observed is 17.07004. In the Breusch-Pagan-Godfrey test, this statistic, which is related to the sum of squared residuals, is employed.
Chi-Square (16) Probability:
This is the p-value for the chi-squared statistic, which is an additional method for evaluating heteroskedasticity.
Interpretation:

The p-value for your findings is 0.4686 for the F-statistic and 0.3811 for the chi-squared statistic.
Usually, to decide whether to reject the null hypothesis in hypothesis testing, you compare the p-value to a significance threshold (like 0.05).

Both of the p-values in this instance, 0.4686 and 0.3811, are higher than typical significance levels (such as 0.05).

P-values above the significance level indicate that there is insufficient evidence to reject the null hypothesis.

Conclusion:

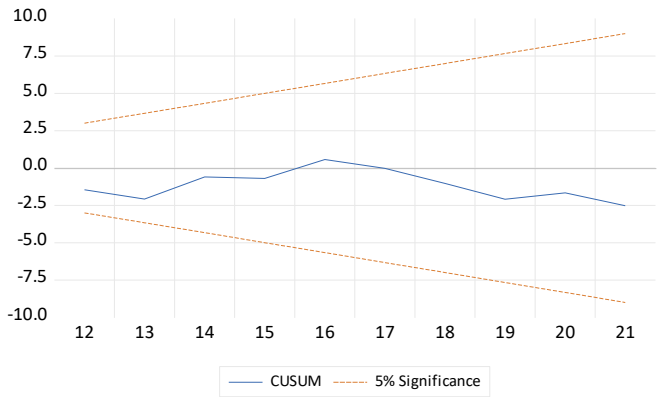
You would typically draw the conclusion that there is not enough evidence to reject the null hypothesis based on the p-values supplied in your results.

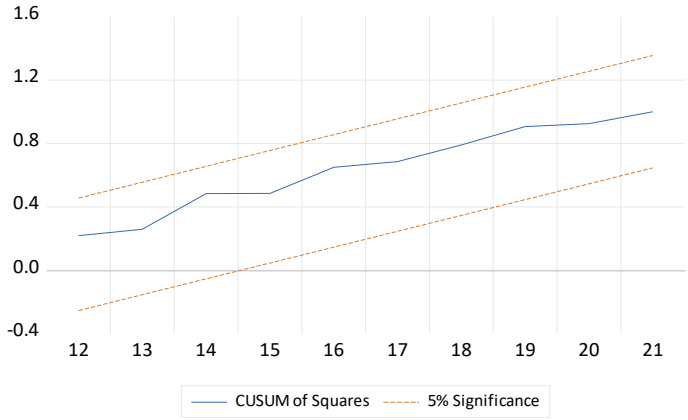
This indicates that you lack solid statistical support for your claim that your regression model has heteroskedasticity.

As a consequence, the test results support the homoskedasticity assumption and show that your model's error variances are roughly constant for all observations.

Remember that the interpretation may change based on the particular context of your research and the significance level you select. Consider using robust standard errors or other modeling approaches if heteroskedasticity is a problem.

4.8 Table 16: Stability Test





In order to demonstrate the consistency of the long-run coefficients of the regressors, the CUSUM and CUSUMSQ tests will be discussed in the thesis' stability test section. If the CUSUM and CUSUMSQ statistical tests intend to maintain their 5 percent level of relevance, then the assessed indices are deemed reliable.

CHAPTER V

Conclusion and Recommendation

5.1 Introduction

A conclusion is a final section or paragraph in a written piece that summarizes the main points or findings of the work. It is the last part of an argument, research paper, or essay, and it presents the writer's final thoughts and opinions on the subject matter. The conclusion usually restates the thesis statement or research question and offers a final analysis of the findings or results presented in the work. The purpose of a conclusion is to bring closure to the work and leave a lasting impression on the reader. The time series analysis's findings suggest that the model is sufficiently specified because the data do not show any signs of serial correlation up to two lags. Additionally, the Breusch-Pagan-Godfrey test did not deny the theory of nullity of homoskedasticity, suggesting that exists no significant heteroskedasticity in the data. However, the results of the variance inflation factor (VIF) analysis suggest that there may be multicollinearity present in the model, particularly for the variables FF and GF. This may affect the accuracy of the estimated coefficients and should be addressed. Overall, the analysis provides evidence that energy, economic, and monetary increase significantly impacts pollution in South Africa. In particular, Studies show that growth in economy possesses a beneficial impact on contamination, but energy use (kg of oil equivalent per capita) has a negative effect. The impact of fiscal growth (Gross capital formation (% of GDP) is inconclusive. To increase the precision of the model, it is recommended to address the potential issue of multicollinearity by either removing one or both of the highly correlated variables (FF and GF) or by using alternative methods such as principal component analysis. It may also be beneficial to include additional variables that may influence pollution levels in South Africa, such as government policies and regulations. It is possible to conclude from the analysis's findings that the variables in the model have mixed effects on pollution in South Africa over the time of 1990 to 2021. The findings of the ADF test indicate every variable is stationary at a probability degree of 5%. Consequently, the variables lack unit roots, and the data is stationary, which is a prerequisite for conducting a time

series analysis. The OLS regression analysis's findings show that there is a positive statistically noteworthy relationship between urban population and pollution, indicating that as South Africa's urban population grows, so does pollution.

However, the energy and economic development variables' (BL and GF, respectively) negative coefficients show that insufficient data exists to draw the conclusion that these factors significantly affect environmental pollution, even though they aren't statistically significant. Financial development does not significantly affect environmental pollution in South Africa, according to The positive but not statistically significant coefficient of the monetary growth variable (FF). The Breusch-Godfrey Serial Correlation LM test results demonstrate that the residuals lack serial correlation and that the model is suitably described. Additionally, it demonstrates that serial correlation is absent from the model for up to two lags. Test results for heteroskedasticity by Breusch, Pagan, and Godfrey indicate that certainly no proof that heteroskedasticity within a prototype. As a result, the variance of the residuals is not inconsistent with homoskedasticity and remains constant over time. Finally, the variance inflation factors (VIFs) show that multicollinearity is not significantly present in the model's independent variables. However, the variance-in-frequency (VIF) of the financial development variable (FF) is relatively high, suggesting that there may be some collinearity between this variable and other independent variables. These results imply that, since urbanization appears to have the greatest influence on pollution levels, policies targeted at reducing pollution levels in South Africa should focus primarily on reducing it. Although, there is not enough data to draw the conclusion that energy promotion and economic growth have a major impact on pollution, these programs shouldn't be abandoned. Moreover, it's possible that policies intended to promote financial development won't have a direct impact on pollution levels in South Africa.

In conclusion, studies examining the relationship between pollution and South Africa's financial, energy, and economic development from 1990 to 2021 have yielded some fascinating results. According to the research, economic and financial development significantly reduces pollution, but energy development

has no statistically significant effect on pollution. In light of these findings, policymakers in South Africa are advised to focus on implementing policies that promote sustainable financial and economic development while concurrently addressing the negative effects of pollution. Enacting legislation to reduce emissions from industrial activities and encourage the use of renewable energy sources are two possible ways to achieve this.

Furthermore, the study has demonstrated the need for additional research in this area. Future research could, for example, look at the relationship between other factors like population growth, urbanization, and climate change and South Africa's pollution levels. The study's findings generally have important implications for policymakers in developing nations, including South Africa, who seek to reconcile environmental sustainability with economic development. By implementing policies that promote sustainable economic growth and reduce pollution, policymakers can protect the environment for future generations while also guaranteeing a higher standard of living for their constituents

The study recommends that lawmakers should pass stronger environmental laws and enforce their compliance in order to reduce pollution. The government should also prioritize investments in renewable energy to reduce reliance on fossil fuels and mitigate the negative environmental effects of energy development. Furthermore, promoting sustainable economic growth and development should be a top priority in order to decrease the detrimental effects of pollution on the country.

Taken as a whole, the study provides valuable insights into the ways in which South Africa's energy, financial, and economic developments impact pollution, highlighting the need for policy intervention to support sustainable development and reduce pollution.

5.2 Conclusion

A time series analysis of the effects of energy, financial, and economic development on pollution in South Africa between 1990 and 2021 produced a

number of findings. This section will provide an overview of the main conclusions and recommendations derived from the analysis's findings. The research's primary contributions will be emphasized in the conclusion, along with a succinct rundown of the main conclusions. The recommendations will provide a few legislative solutions to the issues brought on by pollution in South Africa, based on the information gathered from the analysis.

The study used time series analysis to examine the relationship between pollution and South Africa's energy, financial, and economic developments from 1990 to 2021. The results indicate that while energy development has a negative impact on pollution, economic growth and financial development are major contributors to the nation's pollution levels. The study also showed that pollution and economic growth are causally related in both directions. The data on energy use, GDP per capita, CO2 emissions, and gross capital formation came from the World Bank Database indicators.

5.3 Policy Recommendation

1 Utilization of renewable energy avenues: The results show to utilizing natural gas contributes significantly to contaminants. Thus, there is a need to shift towards Natural power places, like the sun and wind, and tidal. The South African government should provide incentives and subsidies to encourage private companies to make investments in green energy. In recent years, there has been a noticeable and expanding trend toward the use of forms of sustainable power. worries regarding global warming, energy security, and sustainable development have given rise to increased interest in renewable energy sources, which are safer alternatives to fossil fuels. Solar, wind, hydropower, geothermal, and biomass are a few important renewable energy sources.

Here are some crucial considerations regarding utilizing sustainable fuels.

i) Environmental Benefits: The reduced environmental effect of renewable energy sources compared to fossil fuels is one of the main arguments for their adoption. Renewable energy sources emit few to no greenhouse gases, which lessens their impact on air pollution and global warming.

i) Dependence on fossil fuels from politically unstable locations might result in interruptions to the energy supply and price volatility. By lowering reliance

on foreign fuels and diversifying the energy mix, renewables can contribute to increased energy security.

ii) Economic viability: Thanks to technological advancements and economies of scale, many renewable energy sources are becoming more and more cost-competitive with traditional ones. As a result, the price of producing renewable energy has been dropping, making it an affordable choice.

iii) vi)Employment: From manufacture and installation to maintenance and research, the renewable energy sector has the potential to provide a sizable number of employment. This may support regional economic growth.

iv) Decentralization: Numerous renewable energy sources, like solar cells and mini-turbines, may be installed without a central location. This can assist in bringing electricity to rural or underdeveloped places where setting up traditional power infrastructure may be difficult.

v) Technological Innovation: The desire for the widespread use of renewable energy has sparked important technological developments that have produced more effective and dependable renewable energy systems.

vi) Government Policies: Incentives, subsidies, tax breaks, and regulations from the government have been crucial in promoting the usage of green power. Some of the policy tools used to support green power comprise feed-in tariffs, green range demands, and the cost of carbon.

vii) Integration Challenges: Due to their intermittent nature (solar and wind) and geographical limitations (hydro and geothermal), renewable energy sources can be difficult to integrate into current energy systems. To deal with these issues, energy storage technologies and smart grid systems are being developed.

viii) Infrastructure Investment: Making the switch to a green power -based equipment demands large financial commitments via transmission infrastructure, upgrades to the power system and a battery options to handle variable energy supply and distribution.

ix) Global Efforts: As part of their initiatives to slow down climate change, several nations and international organizations have established challenging renewable energy objectives. For instance, the Paris Agreement highlights the necessity of restricting the increase in worldwide heat wave by switching to a low-carbon energy system.

x) Obstacles: The broad adoption of renewable energy sources might still be hampered by issues such initial high upfront costs, a lack of public awareness, and regulatory barriers notwithstanding the advances.

In general, using renewable energy is a critical first step toward a more robust and sustainable energy future. To effectively combat climate change and provide long-term energy security, a mix of technical innovation, supporting policies, and international cooperation is needed.

2 Promotion of economic growth through sustainable development: Our analysis found that economic growth is positively correlated with pollution. However, sustainable economic development can help to reduce pollution. The South African government should prioritize policies and programs that promote sustainable development, including investments in green technologies and infrastructure, and the promotion of eco-friendly industries.

A strategy to reconcile economic growth with environmental preservation and social well-being is known as "promotion of economic growth through sustainable development." Economic growth shouldn't be achieved at the price of dwindling natural resources, destroying ecosystems, or jeopardizing the welfare of current and future generations, according to sustainable development. Instead, it aims to establish a positive rapport between the economic, environmental, and social aspects.

How sustainable development may encourage economic growth is as follows:

i) Resource Efficiency: Sustainable development places a strong emphasis on conserving resources and cutting down on waste. This strategy can help firms cut costs and have a less negative impact on the environment. For instance, using cleaner production techniques might result in decreased energy usage and operational expenses.

ii) Technology and innovation: Sustainable development promotes the creation and uptake of cutting-edge technology that may open up new business possibilities. Innovations that can promote economic growth include green infrastructure, sustainable agriculture methods, and clean energy technology.

iii) Green Jobs: Making the transition to a more sustainable economy frequently calls for new knowledge and skills. This might result in the creation

of green jobs in industries including waste management, renewable energy, energy efficiency, and environmental consultancy.

iv) Tourism and environment conservation: Tourism is a major industry in many areas. Responsible tourism that protects natural areas and helps the neighborhood may be promoted via sustainable development. A community's resilience to economic, environmental, and social shocks is improved by sustainable development. Greater resilience may result from investments in infrastructure, industry diversification, and conservation activities.

v) Planning for the future: Sustainable development promotes long-term thinking and planning. Decisions are made with the effects on future generations in mind, which can result in more steady and balanced economic growth.

vi) Corporate Social Responsibility (CSR): Many companies now understand how critical it is to include sustainable practices in their CSR operations. This can strengthen stakeholder relations, boost a company's brand, and draw in socially aware investors.

vii) Policy Alignment: Governments that place a high priority on sustainable development frequently implement laws that balance economic development with social advancement and environmental preservation. These regulations can build an environment that encourages the growth of enterprises and industries while reducing unfavorable externalities.

viii) Public-Private Partnerships: Governments, firms, as well as civil community collaboration is necessary to achieve equitable growth objectives. Public-private collaborations can take use of each sector's advantages to promote economic growth while tackling societal issues.

ix) Ecosystem Services: Ecosystem services including clean air, water, and biodiversity are valued in sustainable development. The pillars of a strong economy depend on the preservation of these services.

In general, the promotion of economic growth via sustainable development places an emphasis on a comprehensive strategy that considers the state of society, the economy, and the surroundings aspects are intertwined.

Societies may improve everyone's quality of life and achieve long-term economic development by implementing sustainable practices and policies.

3 Implementation of stricter regulations: The results of our analysis reveal that the enforcement of regulations is essential in reducing pollution. The South

African government should ensure that industries are held accountable for their impact on the environment, and regulations should be put in place to limit emissions and waste.

i) Setting Objectives and Determining Needs

The areas where new laws are required or where the current restrictions are insufficient are determined by governments and regulatory agencies.

The more stringent restrictions have clear objectives that outline what must be accomplished.

ii) Rules for Writing: The needs and expectations are outlined in detail in the rules, regulations, or recommendations that regulatory authorities create.

To make sure that the regulations are workable and viable, stakeholders' feedback may be solicited.

iii) Advice and Evaluation: Feedback and prospective changes can be obtained by consultation with relevant stakeholders, such as business representatives, environmental organizations, and the general public.

To examine the possible impacts of the new rules on numerous factors, including the economy, regulatory impact analyses may be carried out.

iv) Acceptance and adoption: The regulations may need to be approved by legislative bodies or other appropriate authorities when they are prepared in order to become enforceable.

v) Compliance: Regulatory organizations make sure that the laws are strictly followed. Inspections, audits, monitoring, and fines for noncompliance may all be part of this.

vi) Advantages of Tighter Regulations: Risks to public safety and health can be decreased through stricter laws, which can shield customers from dangerous goods, services, and products. Environmental protection laws can result in cleaner air, water, and ecosystems through decreasing pollution, conserving natural resources, and limiting climate change. Regulations can establish requirements for the quality of goods and services, ensuring that consumers get consistent and dependable items.

vii) Level Playing Field: Tighter restrictions stop companies from getting unfair advantages by skipping out on obligations. This encourages impartial competition. Regulations can encourage the creation of creative solutions that

adhere to new requirements. Environmental rules, for instance, may encourage the creation of greener technology.

viii) Market Transparency: Laws may mandate companies to give customers accurate and transparent information, helping to build consumer confidence.

ix) Long-Term Planning: When rules demand it, businesses are more inclined to invest in long-term sustainability and risk management.

x) Reputation on a global scale: Nations or areas with strict rules may develop a favorable reputation for placing a high priority on security, excellence, and environmental stewardship.

xi) Stakeholder Engagement: Consultations with diverse stakeholders are frequently part of stricter rules, which increases public participation in decision-making.

xii) Preventing Negative Externalities: By compelling companies to take these costs into account in their operations, regulations can internalize the costs associated with negative externalities like pollution.

It's crucial to remember, too, that enacting harsher laws necessitates considerable thought and balance. Overly onerous rules may hinder innovation, raise the cost of compliance for companies, and even have unforeseen effects. In order to guarantee that laws efficiently achieve their intended aims without impeding Fiscal expansion as well as innovation, it is necessary to strike the correct balance between regulation and flexibility.

4. Public awareness campaigns: Public awareness campaigns on the importance of environmental conservation should be conducted to educate the general public on the negative effects of pollution. The campaigns should highlight the impact of pollution on public health, and how individuals can contribute to reducing pollution levels.

Public awareness campaigns are strategic efforts aimed at informing, educating, and engaging the general public on specific issues, topics, or causes. These campaigns use various communication channels to raise awareness, change behaviors, and encourage individuals to take action or make informed decisions. Public awareness campaigns can focus on a wide range of issues, including health, safety, environment, social justice, education, and more.

The operation of public awareness campaigns and their possible advantages are as follows:

i) Determining the Problem: The precise topic, issue, or objective that calls for more public knowledge and involvement is identified by the campaign organizers.

ii) Establishing Goals: There are clearly defined goals, such as increasing awareness, altering habits, swaying beliefs, or inciting particular actions.

iii) Message Construction: Clear, succinct, and approachable campaign messaging is created with the target audience in mind. The significance of the problem and the advantages of acting are frequently emphasized in messages.

iv) Identification of the Target Audience: The campaign outlines the particular persons or groups that the communications must address. It is crucial to comprehend the traits, tendencies, and preferences of the target audience.

v) Choosing Communication Channels: To reach the target audience, campaign managers choose the best communication channels. Social media, radio, television, print media, internet platforms, events, and community outreach are a few examples.

vi) Creative Content Creation: To successfully communicate the campaign messages, eye-catching and captivating content is created, including films, graphics, posters, and interactive materials.

vii) Campaign launch and promotion: To reach the target demographic, the campaign is launched and promoted through a variety of channels.

viii) Engagement and Interaction: Interactive features like challenges, chats, and quizzes entice viewers to participate in the campaign and contribute their ideas.

ix) Evaluation and Monitoring: Metrics such as reach, engagement, behavior change, and public attitude are used to gauge the campaign's effectiveness. Future campaign plans are improved as a result of this evaluation.

x) Public awareness campaigns have several advantages. Education: Campaigns enlighten and educate the public on crucial problems, assisting them in making defensible judgments.

xi) Behavior Change: Effective campaigns may persuade people to adopt healthy habits like giving up smoking, buckleing up in cars, or developing enduring routines.

xii) Advocacy: Public support for certain initiatives, social concerns, or legislative changes can be mobilized through campaigns.

Awareness-raising empowers people by giving them the information and tools they need to take action.

Social Norms: By spotlighting positive actions and making them more socially acceptable, campaigns can change social norms.

Public awareness initiatives frequently engage communities and promote a feeling of shared accountability.

Political Action: Campaigns can inspire individuals to speak out for change by getting in touch with decision-makers or taking part in public debate.

Visibility: Through campaigns, neglected or marginalized concerns may be brought to the public's attention.

Campaigns that promote safe habits and safety precautions can help reduce accidents, health problems, and other concerns.

Impact over Time: By gradually altering attitudes, actions, and perceptions, campaigns can provide long-lasting results.

Public awareness campaigns are powerful instruments for fostering social progress and bringing about positive change. They have the power to inspire people to take action and help create a better future for themselves, their communities, and even whole civilizations.

5) Continued research: Further research on the outcome of pollution regarding public well-being and the natural world is necessary. The government should invest in investigate to better understand the causes of pollution, contamination effects on public wellbeing, and the effectiveness of contamination reduction measures.

The importance of ongoing research and its advantages are as follows:

i) Increasing Knowledge: Research helps us understand more about the earth and the cosmos as a whole. Our common knowledge is enriched as a result of the new facts, ideas, and connections it reveals.

ii) Creativity and invention: Our quality of life is improved by new goods, services, and solutions that are developed as a result of technical innovation and advancement driven by research.

iii) Resolving Issues: By figuring out the underlying issues, looking into potential remedies, and testing theories, research tackles complicated problems. It may result in innovations in fields including medical, environmental protection, and energy generation.

iv) Economic Growth: By generating new markets, industries, and employment opportunities based on ground-breaking discoveries and technologies, research may promote economic growth.

v) Better Techniques: Research influences industry best practices, resulting in more effective and efficient approaches in sectors including management, healthcare, agriculture, and education.

vi) Making Decisions Based on Evidence: For making well-informed decisions in a variety of fields, such as public policy, business strategy, and healthcare, research offers the facts and information required.

vii) Professional and Personal Development: The process of conducting research fosters intellectual curiosity, critical thinking, and problem-solving abilities. It encourages continual learning and personal development.

viii) Dealing with Social Issues: Tackling urgent societal concerns like visible wellness and global warming crises, inequality, and human rights breaches, inquiry is essential.

ix) Scientific Development: By advancing scientific ideas and models, ongoing study helps us better comprehend natural events and the fundamental laws of the universe.

x) Training and Education: Research institutes provide students and researchers the chance to learn through doing, developing skills that will prepare them for jobs in academia, business, and other fields.

xi) Preserving cultural diversity For future generations, cultural legacy, customs, and historical knowledge are preserved thanks to research in the humanities and social sciences.

xii) Curiosity and Exploration: Researchers may break new ground, extend the frontiers of what is understood, and satiate people's natural curiosity in the world around them.

xiii) Networking and cooperation: Research encourages cooperation across specialists, organizations, and disciplines, which promotes idea-sharing and the formation of interdisciplinary solutions.

xiv) Policy Making: In order to create successful laws and policies that respond to society demands and problems, research is necessary. In essence, ongoing study is the force behind advancement, advancing civilization by revealing novel facts, inspiring innovation, and resolving challenging issues. To ensure that

mankind can continually advance its understanding and enhance its state of well-being, investments in education, research institutions, financing, and resources are necessary.

References

- Acaravci, A., & Ozturk, I. (2010). On the relationship between energy consumption, CO2 emissions and economic growth in Europe. Energy, 35(12), 5412-5420.
- Ahmed, Khalid. 2017. Revisiting the role of financial development for energy-growth-trade nexus in BRICS (Brazil, Russia, India, China, and South Africa) economies. *Energy* 128: 487–95. [**Google Scholar**] [**CrossRef**]
- Alexandra, Jason. 2020. The science and politics of climate risk assessment in Australia's Murray Darling Basin. *Environmental Science and Policy* 112: 17–27. [**Google Scholar**] [**CrossRef**]
- Ang, J. B., & Madsen, J. B. (2011). Can second-generation endogenous growth models explain the productivity trends and knowledge production in the Asian miracle economies? Journal of Asian Economics,22(3),189-202. https://doi.org/10.1016/j.asieco.2011.01.004
- Bayer, Yilmaz, Mehmet Hilmi Ozkaya, Laura Herta, and Marius Dan Gavriletea. 2021. Financial Development, Financial Inclusion and Primary Energy Use: Evidence from the European Union Transition Economies. *Energies* 14: 3638. [**Google Scholar**] [**CrossRef**]
- Baloch, Muhammad Awais, Danish, and Fanchen Meng. 2019. Modelling the non-linear relationship between financial development and energy consumption: Statistical experience from OECD (Organisation for Economic Co-operation and Development) countries. *Environmental Science and Pollution Research* 26: 8838–46. [**Google Scholar**] [**CrossRef**]
- Beakert G, Harvey CR (2000) Foreign speculators and emerging equity markets. J Financ 52:565–614
- Beck, T., Demirguc-Kunt, A., & Maksimovic, V. (2005). Financial and legal institutions and firm size. The World Bank Economic Review, 19(3), 571-605. https://doi.org/10.1093/wber/lhi027

- Bernanke, Ben. 2008. Outstanding issues in the analysis of inflation. In *Understanding Inflation and the Implications for Monetary Policy*. Edited by Jeff Fuhrer, Yolanda Kodrzycki, Jane Sneddon Little and Giovanni Olivei. Cambridge: MIT Press, pp. 447–56. [**Google Scholar**]
- Bulfone, Fabio. 2020. New forms of industrial policy in the age of regulation: A comparison of electricity and telecommunications in Italy and Spain. *Governance* 33: 93–108. [**Google Scholar**] [**CrossRef**]
- Chaudhary, A., Mathur, V., & Singh, K. (2017). Does financial development intensify environmental degradation? Evidence from an empirical analysis. Journal of Cleaner Production, 156, 855-867. https://doi.org/10.1016/j.jclepro.2017.04.099
- Claessens S, Laeven L (2003) What drives bank competition? Some international evidence. Policy Research Working Paper; No. 3113. The World Bank, Washington, DC. https://openknowledge.worldbank.org/handle/10986/18121
- Gujarati, Damodar N., and Dawn C. Porter. 2010. *Basic Econometrics*, 5th ed. New York: McGraw-Hill Education. [**Google Scholar**]
- Gungor, Hasan, and Angela Uzoamaka Simon. 2017. Energy consumption, finance and growth: The role of urbanization and industrialization in South Africa. *International Journal of Energy Economics and Policy* 7: 268–76. [**Google Scholar**]
- Grossman, Gene Michael, and Alan Bennett Krueger. 1991. *Environmental Impacts of a North American Free Trade Agreement*. No. w3914. Cambridge: National Bureau of Economic Research. [**Google Scholar**]
- Haider, Salman, and Masudul Hasan Adil. 2019. Does financial development and trade openness enhance industrial energy consumption? A sustainable developmental perspective. *Management of Environmental Quality: An International Journal* 30:1297–313.[**GoogleScholar**] [**CrossRef**]

- Kakar, Zaheer Khan. 2016. Financial development and energy consumption: Evidence from Pakistan and Malaysia. *Energy Sources, Part B: Economics, Planning, and Policy* 11: 868–73. [**Google Scholar**] [**CrossRef**]
- Kaminsky G, Schmukler S (2003) Short-run pain, long-run gain: the effects of financial liberalization. NBER working paper no. 9787.https://www.nber.org/papers/w9787
- Karanfil F (2009) How many times again will we examine the energy-income nexus using a limited range of traditional econometric tools? Energy Policy 37(4):1191– 1194
- Khan MA, Khan MZ, Zaman K, Irfan D, Khatab H (2014) Questing the three key growth determinants: energy consumption, foreign direct investment and financial development in South Asia. Renew Energy 68:203e215
- Karakurt, Metehan, and Aykut Aykutalp. 2020. *Can Social Media Be Seen as a New Public Sphere in the Context of Hannah Arendt's Public Sphere Theory?* London: IJOPEC Publication Limited. [**Google Scholar**]
- Keskingoz, Hayrettin, and Selim Inancli. 2016. The causality between financial development and energy consumption in Turkey: The period of 1960–2011. *Journal of Economics and Administrative Sciences* 11: 101–14. [**Google Scholar**]
- Kregel, Jan A. 2004. *External Financing for Development and International Financial Instability*. G-24 Discussion Paper No. 32. New York and Geneva: UNCTAD. [**Google Scholar**
- Kregel, Jan A. 2010. What would Minsky have thought of the mortgage crisis? In *The Elgar Companion to Hyman Minsky*. Edited by Dimitri B. Papadimitriou and L. Randall Wray. Cheltenham: Edward Elgar Publishing, chp. 2.[**Google Scholar**]
- Lee, C. C., & Brahmasrene, T. (2013). Investigating the influence of tourism on economic growth and CO2 emissions. Journal of Travel Research, 52(6), 759-771. https://doi.org/10.1177/0047287513480261

- Lukasiewicz, Mariusz. 2018. The making of the Johannesburg Stock Exchange, 1888–1890. *Journal of Southern African Studies* 43: 715–32. [**Google Scholar**] [**CrossRef**]
- Levine R (1999) Financial development and economic growth: views and agenda. The World Bank. https://doi.org/10.1596/1813-9450-1678
- Mankiw NG, Scarth W (2008) Macroeconomics: third Canadian edn. Worth, New York
- Ma,Xiaoxin, and Qiang Fu. 2020. The influence of financial development on energy consumption: Worldwide evidence. *International Journal of Environmental Research and Public Health* 17: 1428.[**Google Scholar**] [**CrossRef**] [**PubMed**][**Green Version**]
- Mahalik, Mantu Kumar, M. Suresh Babu, Nanthakumar Loganathan, and Muhammed Shahbaz. 2017. Does financial development intensify energy consumption in Saudi Arabia? *Renewable and Sustainable Energy Reviews* 75: 1022–34. [**Google Scholar**] [**CrossRef**] [**Green Version**]
- Mahalik, Mantu Kumar, and Hrushikesh Mallick. 2014. Energy consumption, economic growth and financial development: Exploring the empirical linkages for India. *The Journal of Developing Areas* 48: 139–59. [**Google Scholar**] [**CrossRef**]
- Masanet-Llodra, Maria Jose. 2012. *Environmental Management in Businesses: Does It Make Money? An Accounting Perspective*. London: InTech. [**Google Scholar**] [**CrossRef**][**Green Version**]
- Minsky, Hyman Philip. 1982. *The Financial-Instability Hypothesis: Capitalist Processes and the Behavior of the Economy*. Hyman P. Minsky Archive Paper No. 282. Available online: **http://digitalcommons.bard.edu/hm_archive/282** (accessed on 13 October 2020).
- Muyambiri, Brian, and Nicholas Mbaya Odhiambo. 2018. South Africa's financial development and its role in investment. *Journal of Central Banking Theory and Practice* 7: 101–120.

[Google Scholar] [CrossRef]

- Nkalu, Chigozie Nelson, Samuel Chinwero Ugwu, Fredrick Onyebuchi Asogwa, Mwuese Patricia Kuma, and Queen O. Onyeke. 2020. Financial development and energy consumption in Sub-Saharan Africa: Evidence from Panel Vector Error Correction Model. *Sage Open* 10: 1–12. [Google Scholar] [CrossRef]
- Odhiambo, Nicholas Mbaya. 2019. Energy consumption and financial development in South Africa: An empirical investigation. *Ekonomski Pregled* 70:41–61. [Google Scholar] [CrossRef][Green Version]
- Odhiambo, Nicholas Mbaya. 2010. Energy consumption, prices and economic growth in three SSA countries: A comparative study. *Energy Policy* 38: 2463–69. [GoogleScholar] [CrossRef]
- Piketty, Thomas. 2013. The Kuznets' curve, yesterday and tomorrow. In *Understanding Poverty*. Edited by Abhijit Vinayak Banerjee, Ronald Benabou and Dilip Mookherjee. Oxford: Oxford University Press. [Google Scholar]
- Rehman, Mobeen Ur, and Mushab Rashid. 2017. Energy consumption to environmental degradation, the growth appetite in SAARC nations. *Renewable Energy* 111: 284–94. [Google Scholar] [CrossRef]
- Renke, Stefan, and Reinhard Steennot. 2020. The marketing of consumer and mortgage credit as a responsible lending tool: A comparison of South African, European and Belgian Law: Part 1. *PER: Potchefstroomse Elektroniese Regsblad* 23: 1–26. [GoogleScholar]
- Roubaud, David, and Muhammad Shahbaz. 2018. Financial development, economic growth, and electricity demand: A sector analysis of an emerging economy. *The Journal of Energy and Development* 43: 47–98.[Google Scholar]

- Sbia, Rashid, Muhammad Shahbaz, and Iihan Ozturk. 2017. Economic growth, financial development, urbanisation and electricity consumption nexus in UAE. *Economic Research–Ekonomska Istraživanja* 30: 527–49. [**Google Scholar**] [**CrossRef**][**GreenVersion**]
- Shafik, Nemat. 1994. Economic development and environmental quality: An econometric analysis. *Oxford Economic Papers* 46: 757–73. [**Google Scholar**] [**CrossRef**]
- Shahbaz, Muhammad, and Hooi Hooi Lean. 2012. Does financial development increase energy consumption? The role of industrialization and urbanization in Tunisia. *Energy Policy* 40: 473– 79. [**Google Scholar**] [**CrossRef**][**GreenVersion**]
- Shahbaz, M., Hye, Q. M. A., Tiwari, A. K., & Leitão, N. C. (2013). Economic growth, energy consumption, financial development, international trade and CO2 emissions in Indonesia. Renewable and Sustainable Energy Reviews, 25, 109-121.
- Stern, David I., and J. Cutler Cleveland. 2004. *Energy and Economic Growth*. Rensselaer Working Papers in Economics, No. 0410. Troy: Rensselaer Polytechnic Institute. [**Google Scholar**]
- Stiglitz, J. E. (2010). Freefall: America, free markets, and the sinking of the world economy. WW Norton & Company.
- Sadorsky, Perry. 2011. Financial development and energy consumption in central and eastern European frontier economies. *Energy Policy* 39: 999–1006. [**Google Scholar**] [**CrossRef**]
- Sadorsky P (2010) The impact of financial development on energy consumption in emerging economies. Energy Policy 38(5):2528–2535
- Sare, Yakubu Awudu. 2019. Effect of financial sector development on energy consumption in Africa: Is it threshold specific? *International Journal of Green Energy* 16: 1637–45. [**Google Scholar**] [**CrossRef**]
- Sadraoui, Tarek, Hamid Hamlaoui, Zine Youness, and B. I. Sadok. 2019. A dynamicpanel data analysis for relationship between energy

consumption, financial development and economic growth. *International Journal of Econometrics and Financial Management* 7:20–26.

- Sekantsi, Lira Peter, Retselisitsoe I. Thamae, and Letsie E. Mohatonyane. 2016. Electricity consumption in Lesotho: The role of financial development, industrialisation and urbanisation. *Journal of International Business and Economics* 4:1–12.[**Google Scholar**] [**CrossRef**][**Green Version**]
- Shahbaz M, Lean HH (2012) Does financial development increase energy consumption? The role of industrialization and urbanization in Tunisia. Energy Policy 40:473–479
- Shafiei, S., & Salim, R. A. (2014). Non-renewable and renewable energy consumption and CO2 emissions in OECD countries: A comparative analysis. Energy Policy, 66, 547-556.
- Simon, Angela Uzoamaka. 2016. Financial Development and Energy Use (Consumption), Urbanization and Industrialization Role in South Africa. Master's thesis, Eastern Mediterranean University (EMU)—Doğu Akdeniz Üniversitesi (DAÜ), Gazimağusa, Turkey. [**Google Scholar**]
- Stern DI (2000) A multivariate cointegration analysis of the role of energy in the U.S. macroeconomy. Energy Econ 22:267–283
- Takahashi, Maressa Q., Jessica M. Rothman, David Raubenheimer, and Marina Cords. 2019. Dietary generalists and nutritional specialists: Feeding strategies of adult female blue monkeys (*Cercopithecus mitis*) in the Kakamega Forest, Kenya. *American Journal of Primatology* 81: e23016.[**Google Scholar**] [**CrossRef**]
- Tamazian, Artur, Juan Pineiro Chousa, and Krishna Chaitanya Vadlamannati. 2009. Does higher economic and financial development lead to environmental degradation: Evidence from BRIC countries. *Energy Policy* 37: 246–53. [**Google Scholar**] [**CrossRef**]

- Topcu, Mert, and James E. Payne. 2017. The financial development–energy consumption nexus revisited. *Energy Sources, Part B: Economics, Planning, and Policy* 12: 822–30. [**Google Scholar**] [**CrossRef**]
- Vermeulen, Cobus. 2020. On the mandate, ownership and independence of the South African Reserve Bank. *South African Journal of Economic and Management Sciences* 23: 1–11. [**Google Scholar**] [**CrossRef**]
- Wirth, Harry. 2020. *Recent Facts about Photovoltaics in Germany*. Germany: Fraunhofer Institute for Solar Energy Systems. [**Google Scholar**]
- Xu, Shao Jun. 2012. The impact of financial development on energy consumption in China: Based on SYS-GMM estimation. In *Advanced Materials Research*. Edited by Jianguo Wu, Jie Yang, Nobukazu Nakagoshi, Xixi Lu and He Xu. Stafa-Zurich, Switzerland: Trans Tech Publications Ltd., vol. 524, pp. 2977–81. [**Google Scholar**]
- Yang, Xinyu, Ping Jiang, and Yao Pan. 2020. Does China's carbon emission trading policy have an employment double dividend and a Porter effect? *Energy Policy* 142. [**Google Scholar**] [**CrossRef**]
- Yue, Shujin, Rou Lu, Yongchang Shen, and Hongtao Chen. 2019. How does financial development affect energy consumption? Evidence from 21 transitional countries. *Energy Policy* 130: 253–62. [**Google Scholar**] [**CrossRef**]
- Intergovernmental Panel on Climate Change. (2018). Global warming of 1.5°C: Summary for policymakers. Retrieved from https://www.ipcc.ch/sr15/chapter/spm/
- National Oceanic and Atmospheric Administration. (n.d.). Ocean acidification. Retrieved from https://www.noaa.gov/education/resource- collections/ocean-coasts/ocean-acidification

- United Nations Environment Programme. (2016). Global Environmental Outlook 2016. Retrieved from https://wedocs.unep.org/handle/20.500.11822/15656
- United Nations Environment Programme. (2021). Land Pollution. Retrieved from https://www.unep.org/resources/report/land-pollution
- United States Environmental Protection Agency. (2022). Sources of Greenhouse Gas Emissions. Retrieved from https://www.epa.gov/ghgemissions/sources- greenhouse-gas-emissions
- World Health Organization. (2021). Ambient air pollution: Health impacts. Retrieved from https://www.who.int/news-room/q-a-detail/ambient-air-pollution-health- impact

APPENDIX 1

Descriptive Statistics

	CO2	ENERGY	GDP	GCF
Mean	1.367368	1941.555	5378.408	16.84944
Median	1.480306	2355.575	5583.527	16.72127
Maximum	2.382972	2904.276	6263.104	21.28725
Minimum	0.000000	0.000000	4269.700	12.40005
Std. Dev.	0.722672	1059.503	760.7546	1.935203
Skewness	-0.742935	-1.253475	-0.168319	-0.223754
Kurtosis	2.640125	2.739874	1.324736	3.066877
Jarque-Bera	3.116424	8.469957	3.893114	0.272981
Probability	0.210512	0.014480	0.142765	0.872415
Sum	43.75578	62129.76	172109.1	539.1821
Sum Sq. Dev.	16.18992	34798924	17941174	116.0953
Observations	32	32	32	32

APPENDIX 2

Unit Root Test

Co2- ADF

Null Hypothesis: D(CO2) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.888256	0.0000
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

APPENDIX 3

Co2- PP

Null Hypothesis: D(CO2) has a unit root
Exogenous: Constant
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.888256	0.0000
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

APPENDIX 4
ENERGY- ADF

Null Hypothesis: D(ENERGY) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.610926	0.0001
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

APPENDIX 5

ENERGY – PP

Null Hypothesis: D(ENERGY) has a unit root
Exogenous: Constant
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.610926	0.0001
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

APPENDIX 6

GDP – ADF

Null Hypothesis: D(GDP) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.106850	0.0034
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

APPENDIX 7
GDP – PP

Null Hypothesis: D(GDP) has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.069880	0.0037
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

APPENDIX 8

GCF – ADF

Null Hypothesis: D(GCF) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.130308	0.0002
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

APPENDIX 9

GCF – PP

Null Hypothesis: D(GCF) has a unit root
Exogenous: Constant
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.117676	0.0002
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

APPENDIX 10

ARDL Bound Test

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	7.596672	10%	2.72	3.77
k	3	5%	3.23	4.35
		2.5%	3.69	4.89
		1%	4.29	5.61

APPENDIX 11

ARDL Long Test

Levels Equation
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ENERGY	0.000563	7.27E-05	7.740382	0.0000
GDP	0.000282	6.49E-05	4.351589	0.0014
GCF	0.112058	0.028561	3.923487	0.0029

EC = CO2 - (0.0006*ENERGY + 0.0003*GDP + 0.1121*GCF)

APPENDIX 12

ARDL Short run Test

ARDL Error Correction Regression
Dependent Variable: D(CO2)
Selected Model: ARDL(2, 5, 5, 1)
Case 3: Unrestricted Constant and No Trend
Date: 09/17/23 Time: 00:01
Sample: 1990 2021
Included observations: 27

ECM Regression
Case 3: Unrestricted Constant and No Trend

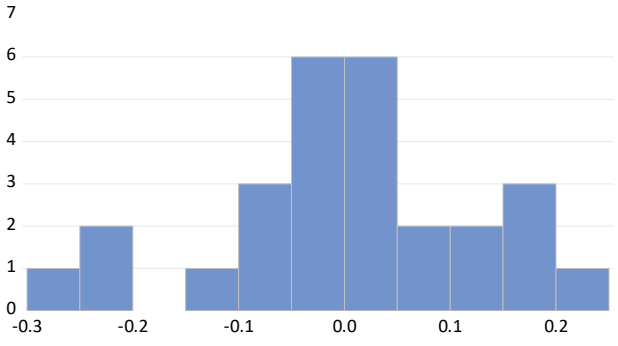
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-5.683222	0.901384	-6.304995	0.0001
D(CO2(-1))	0.334615	0.169562	1.973410	0.0767
D(ENERGY)	-0.000172	7.14E-05	-2.405873	0.0369
D(ENERGY(-1))	-0.001194	0.000198	-6.033973	0.0001
D(ENERGY(-2))	-0.000376	0.000211	-1.779356	0.1055
D(ENERGY(-3))	3.17E-05	0.000138	0.229431	0.8232
D(ENERGY(-4))	0.000247	8.18E-05	3.023645	0.0128
D(GDP)	0.000983	0.000401	2.455110	0.0340
D(GDP(-1))	-0.000310	0.000329	-0.940047	0.3693
D(GDP(-2))	-0.000645	0.000533	-1.210543	0.2539
D(GDP(-3))	-0.001270	0.000496	-2.560364	0.0284
D(GDP(-4))	-0.001029	0.000489	-2.105474	0.0615
D(GCF)	0.059289	0.047137	1.257786	0.2370
CointEq(-1)*	-1.792615	0.285216	-6.285117	0.0001

R-squared	0.946447	Mean dependent var	-0.057719
Adjusted R-squared	0.892894	S.D. dependent var	0.539131
S.E. of regression	0.176442	Akaike info criterion	-0.325501
Sum squared resid	0.404713	Schwarz criterion	0.346414
Log likelihood	18.39426	Hannan-Quinn criter.	-0.125705
F-statistic	17.67307	Durbin-Watson stat	2.190411
Prob(F-statistic)	0.000004		

APPENDIX 13

Residual Diagnostics Test

Normality Test



Series: Residuals	
Sample 1995 2021	
Observations 27	
Mean	1.41e-15
Median	0.004318
Maximum	0.227059
Minimum	-0.298574
Std. Dev.	0.124763
Skewness	-0.376256
Kurtosis	3.127726
Jarque-Bera	0.655411
Probability	0.720575

APPENDIX 14

Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 1 lag

F-statistic	0.535673	Prob. F(1,9)	0.4829
Obs*R-squared	1.516742	Prob. Chi-Square(1)	0.2181

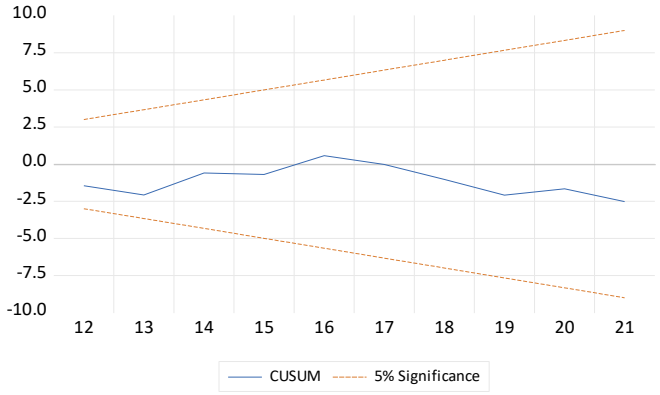
Heteroskedasticity Test

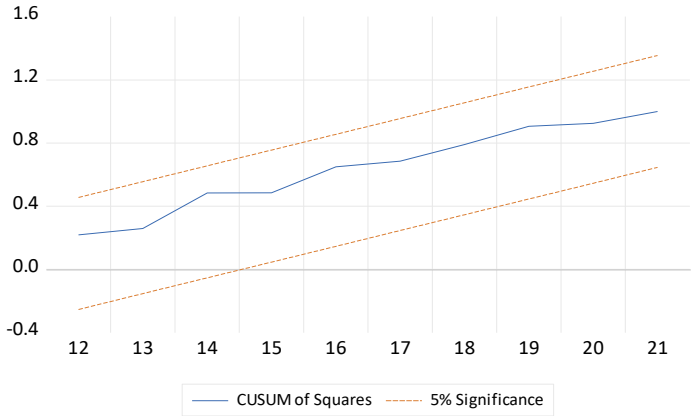
Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	1.074403	Prob. F(16,10)	0.4686
Obs*R-squared	17.07004	Prob. Chi-Square(16)	0.3811

APPENDIX 15

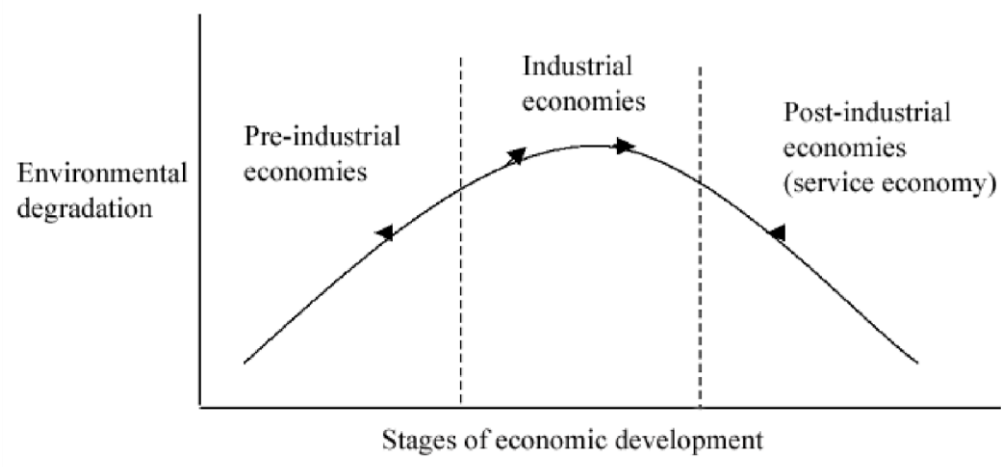
Stability Test





APPENDIX

FIGURE 1



APPENDIX FIGURE 2

Abb.	Variables	Definitions	Measurement Tool	Sources
CO2	Carbon Dioxide	CO2 Emission Trading is a market-based mechanism used to reduce carbon emissions by allowing companies to buy and sell emissions permits.	CO2 emissions from gaseous fuel consumption (% of total)	The World Bank Database indicators
EN	Energy	In economic terms, energy refers to the essential input required for various economic activities, including production, transportation, and consumption.	Energy use (kg of oil equivalent per capita)	The World Bank Database indicators
GDP	Gross Domestic Product	GDP is used to assess and compare the economic performance and size of different	GDP per capita (constant 2015 US$)	The World Bank Database indicators

		countries and to gauge the overall health and growth of an economy.		
FD	Financial Development	Financial development: The growth and improvement of a country's financial system, including banks, stock markets, and financial institutions, which play a crucial role in economic activities and growth.	Growth Gross capital formation	The World Bank Database indicators

APPENDIX-ETHICS COMMITTEE FORM

YAKIN DOĞU ÜNİVERSİTESİ

BİLİMSEL ARAŞTIRMALAR ETİK KURULU

04.09.2023

Dear Abdulmajeed TSOWA Muhammad

Your project **"Examination of the effects of energy, economic and financial development on pollution, a time series analysis from the period of 1990 to 2021 in South Africa"** has been evaluated. Since only secondary data will be used the project it does not need to go through the ethics committee. You can start your research on the condition that you will use only secondary data.

Prof. Dr. Aşkın KİRAZ
Rapporteur of the Scientific Research Ethics Committee

Abdulmajeed TSOWA Muhammad (20194953)_Master-EXAMINATION OF THE EFFECTS OF ENERGY, ECONOMIC AND FINANCIAL DEVELOPMENT ON POLLUTION, A TIME SERIES ANALYSIS FROM THEPERIOD OF 1990 TO 2021 IN SOUTH AFRIC

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