NEAR EAST UNIVERSITY

INSTITUTE OF GRADUATE STUDIES

DEPARTMENT OF ECONOMICS

The dynamic relationship between Co2 emissions, GDP, Urban Population, Energy Consumption and Foreign Direct Investment in Sierra Leone. Using The Environmental Kuznets Curve Hypothesis.

MSc. THESIS

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Alhassan Turay

Supervisor:

Prof. Dr. Hüseyin Ozdeser

Co-Supervisor:

Assist Prof. Dr. Mehdi Seraj

Nicosia

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Approval

We certify that we have read the thesis submitted by **ALHASSAN TURAY** titled **"The dynamic relationship between Co2 emissions, GDP, Urban Population, Energy Consumption and Foreign Direct Investment in Sierra Leone. Using The Environmental Kuznets Curve Hypothesis"**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. Dr. Huseyin Ozdeser	…………………
Committee Member:	Asst. Prof. Dr Mehdi Seraj	…………………
Committee Member:	Assoc. Prof. Dr. Turgut Tursoy	…………………
Committee Member:	Dr. Abidemi Somoye	…………………
Supervisor:	Prof. Dr. Huseyin Ozdeser	…………………

Approved by the Head of the Department

08/02/2023

Prof. Dr. Huseyin Ozdeser

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.

Alhassan Turay

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Acknolowdgement

Throughout the stay and process of this industrious journey of academic pursuit it has been Allah. His grace, guidance and protection has kept me strong, determined in achieving my goals.

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Alhassan Turay

Abstract

The dynamic relationship between Co2 emissions, GDP, Urban Population, Energy Consumption and Foreign Direct Investment in Sierra Leone. Using The Environmental Kuznets Curve

Alhassan Turay

Supervisor: Prof. Dr. Huseyin Ozdeser.

Co-Supervisor: Asst. Prof. Dr. Mehdi Seraj

MSc, Department of Economics

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This study examines the relationship between CO2 emissions, urban population growth, energy consumption, and foreign direct investment in order to investigate the environmental Kuznets curve and pollution haven hypotheses in Sierra Leone. Additionally, the study looks at how these factors are related to foreign direct investment. This investigation makes use of annual time series data from 1980-2020 and applies the Nonlinear Autoregressive distributed Lag model developed by Shin et al. (2014) in order to examine the asymmetric influence that the independent variables have on the variable that is being investigated (C02). According to the outcome of the ADF test, energy consumption, economic growth, and urban population growth are integrated at level (I (0), at a level of significance of 1% for both EC and GDP, and at a level of significance of 5% for UPG. This was found to be the case. Both FDI and CO2 are included at the first difference level, which is set at 1% significant level. The NARDL bound test that was conducted by Shin et al. (2014) was able to confirm the presence of a long run cointegrating connection between the variables. The findings of this research provide evidence that the Environmental Kuznets curve and the pollution haven hypothesis are correct with regard to Sierra Leone. According to the findings of this research, fluctuations in GDP, both upward and downward, as well as fluctuations in FDI, both positive and negative, contribute to reductions in carbon dioxide emissions in the short term. The error correction term, abbreviated as ect, demonstrates the rate of adjustment, which stands at 13.36% and works to restore equilibrium in the long run. According to the conclusions of this research, the central government should continue to enact legislation that would support green environmental practices and, as a result, safeguard the ecosystem from future depletion. The allowed foreign direct investment (FDI) inflows into Sierra Leone need to be carefully organized and limited to a productive and creative technical footprint in order to promote FDI as well as urbanization, clean energy consumption, and considerable economic development. In order to solve the problems of long-term environmental sustainability, it is necessary to enact policies that are geared toward mitigating the adverse effects of climate change.

Key Words: sierra leone, economic growth, nardl, bound, cointegration, fdi, co2 emissions.

Öz

Sierra Leone'de Co2 emisyonları, GSYİH, Kentsel Nüfus, Enerji Tüketimi ve Doğrudan Yabancı Yatırım arasındaki dinamik ilişki. Çevresel Kuznets Eğrisini Kullanma.

Alhassan Turay

Supervisor: Prof. Dr. Huseyin Ozdeser.

Co-Supervisor: Asst. Prof. Dr. Mehdi Seraj

MSc, Department of Economics

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Bu çalışma, Sierra Leone'deki çevresel Kuznets eğrisi ve kirlilik cenneti hipotezlerini araştırmak için CO2 emisyonları, kentsel nüfus artışı, enerji tüketimi ve doğrudan yabancı yatırım arasındaki ilişkiyi incelemektedir. Ek olarak, çalışma, bu faktörlerin doğrudan yabancı yatırımla nasıl ilişkili olduğunu inceliyor. Bu araştırma, 1980-2020 yılları arasındaki yıllık zaman serisi verilerini kullanır ve Shin ve diğerleri tarafından geliştirilen Doğrusal Olmayan Otoregresif dağıtılmış Gecikme modelini uygular. (2014), bağımsız değişkenlerin araştırılan değişken üzerindeki asimetrik etkisini incelemek için (C02). ADF testinin sonucuna göre, enerji tüketimi, ekonomik büyüme ve kentsel nüfus artışı, (I (0) düzeyinde, hem AT hem de GSYİH için %1 önem düzeyinde ve önem düzeyinde entegre edilmiştir. UPG için %5. Durum böyle bulundu. %1 anlamlılık düzeyinde ayarlanan birinci fark düzeyinde hem FDI hem de CO2 yer almaktadır.Shin ve diğerleri (2014) tarafından yapılan NARDL sınır testi değişkenler arasında uzun dönemli bir eşbütünleşme ilişkisinin varlığını doğrulayabilmektedir.Bu araştırmanın bulguları, Çevresel Kuznets eğrisinin ve kirlilik cenneti hipotezinin Sierra Leone için doğru olduğuna dair kanıt sağlamaktadır.Bu araştırmanın bulgularına göre, dalgalanmalar Hem yukarı hem de aşağı yönlü GSYİH ve DYY'deki hem pozitif hem de negatif dalgalanmalar, kısa vadede karbondioksit emisyonlarının azalmasına katkıda bulunur. %13,36'da duruyor ve uzun vadede dengeyi sağlamaya çalışıyor. Bu araştırmanın sonuçlarına göre, merkezi hükümet yeşil çevre uygulamalarını destekleyecek ve sonuç olarak ekosistemi gelecekteki tükenmelerden koruyacak yasalar çıkarmaya devam etmelidir. Sierra Leone'ye izin verilen doğrudan yabancı yatırım (FDI) girişlerinin dikkatli bir şekilde organize edilmesi ve DYY'nin yanı sıra kentleşmeyi, temiz enerji tüketimini ve önemli ölçüde ekonomik kalkınmayı teşvik etmek için üretken ve yaratıcı bir teknik ayak izi ile sınırlandırılması gerekir. Uzun vadeli çevresel sürdürülebilirlik sorunlarının çözümü için iklim değişikliğinin olumsuz etkilerinin azaltılmasına yönelik politikaların hayata geçirilmesi gerekmektedir.

Anahtar Kelimeler: sierra leone, ekonomik büyüme, nardl, sınır, eş bütünleşme, fdi, co2 emisyonları.

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ABBREVIATIONS

NARDL	Nonlinear Auto Regressive Distributed Lag
CO2	Carbon dioxide Emissions
EC	Energy Consumption
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
UPG	Urban Population Growth
GHG	Greenhouse Gas
IPCC	Inter Governmental Panel on Climate Change
EKC	Environmental Kuznets Curve
UNDP	United Nation Development Program
IRENA	International Renewable Energy Agency
UNFCC	United Nation Framework Convention on Climate Change
MW	Mega Watt
UNIDO	United Nation Industrial Development
KW	Kilo Watt
BKPS	Bo Kenema Power Services
PRESSD	Promoting Renewable Energy Services for Social Development
UNOPS	United Nations Office for Project Services
UNICEF	United Nations Children’s Fund
UNCTAD	United Nations Conference on Trade and Development
WDI	World Development Indicators

CHAPTER I

Introduction

Achieving and maintaining the appropriate degree of economic advancement and prosperity is the fundamental objective of every country. When trying to expand economically, countries run across a lot of obstacles. The contamination and destruction of the natural world is a major issue. However, the world's supply of conventional fuels is quickly dwindling, and the world's reliance on them for energy is becoming more unsustainable. Emissions of these gases contribute to a rise in atmospheric carbon dioxide, which has devastating effects on both vegetation and the climate. Drought, flooding, tornadoes, rising sea levels, and the melting of glaciers are just some of the catastrophic climatic changes that result. In recent years, global warming and climatic variation have emerged as one of the most pressing ecological issues for both industrialized and emerging nations.

Emissions of carbon dioxide (CO2) have risen dramatically due to a rise in worldwide commerce and travel as well as a general rise in economic activity across the globe. Wasteful practices and excessive energy use lead to a deteriorating natural environment. The connection between progress in industry and a better environment has been the subject of heated discussion for considerable time.

A short overview of the research thesis, hypothesis, questions, aims, importance, scope, and constraints are presented in this chapter.

1.1.0 Background

The Panel on Climate Change (2014) reports that the climate is being increasingly and irreversibly impacted by human activities. Anthropogenic greenhouse gas (GHG) concentrations are at an all-time high and are raising the average temperature of the atmosphere and the ocean. The arctic ice of Antarctica and Greenland are receding, which is raising sea levels. The sea environment has become 26% more acidic during the industrial revolution because of the accumulation of carbon dioxide (CO2). Magnitude of rainfall shift, as do the migratory routes and seasonal activity of many species. Many nations have seen a dramatic decline in agricultural output as a result of global warming, which poses a danger to food security and adds to the health problems that people already confront. Furthermore, since around 1950, the frequency of severe weather occurrences has been on the rise (IPCC 2014). To tackle these issues, exacerbated by climate change, it is important to understand what factors are at play. According to IPCC's most recent assessment report (2014), rising economies and populations are the primary causes of this rise in CO2 emissions. However, the share of blame placed on rising populations has stayed the same, while the influence of rising economies had risen dramatically recently, or during the last several years (IPCC 2014). Riti et al. (2017) state that rising GHG emissions, brought on by a booming economy, harm the planet's ecosystems and ultimately cause its destruction. On the other hand, a thriving economy is crucial. In particular, those on lower incomes will benefit from a flourishing economy in the form of improved living conditions (lower rates of sickness and malnourishment) (Kivyiro and Arminen 2014). The pursuit of economic expansion, however, is ingrained in the culture of even the most industrialized nations (Friedman 2006). Therefore, modern policy frameworks aim to increase GDP while simultaneously decreasing carbon emissions and increasing use of renewable energy sources (Lee 2013). It's possible to connect this objective with the emerging and more popular term "green growth" over the last ten years (Jacobs 2013). " Efficient and sustainable economic growth that minimizes negative impacts on the environment and improves the quality of life for all citizens is what we mean when we talk about sustainable development" as defined by the World Bank (2018, p.4). Efforts to reduce carbon emissions have been done on a global scale in past few decades. Is thus embodied in international accords like the Paris Agreement, where signatories commit to keeping average global warming beneath an increase in temperature above pre-industrial temperatures at under 2 ° c, and ideally to 1.5c. Conversely, there is a tipping point at a given income level, after which emissions declines (although income continues to rise).

Foreign direct investment (FDI) is sought by many nations in the hope that it would spur economic development at home (i.e., the country receiving FDI). FDI helps economies in many ways, including capital creation, increases in productive capacity, increased competitiveness of the nation, and the introduction of cutting-edge technology (Lee 2013). Many companies have been funneling money into emerging markets during the 1990s. International corporations, according to Nunnenkamp (2002), look for places with cheap production expenses as a result of globalization and the increased accessibility of the market. Global foreign direct investment (FDI) boosts output and fuels economic expansion. Furthermore, there is minimal agreement in the published research on the effects of FDI on ecosystems. Two conflicting theories attempt to account for the link between FDI and environmental deterioration: the pollution haven theory and the pollution halo theory. The first hypothesis holds that emerging nations have a competitive edge in polluting industries owing to lax environmental laws. Foreign direct investment (FDI) flows in, driving output growth. There is a trend toward dirty industries in these nations, and this, along with increased output, results in more emissions (i.e., scale effect). The pollution halo theory suggests that the scale effect may be mitigated by the diffusion of better innovations as a result of an infusion of offshore cash (i.e., the technique impact) as well as a modification in the composition of the industry (i.e., the composition effect). It would be helpful to have more data on the correlations between the variables so that policymakers may better understand the causes and effects at play (Kivyiro and Arminen 2014). When reviewing the current research, however, energy use is clearly linked to both CO2 emissions and the aforementioned variables. Lee (2013) suggests that FDI and economic expansion are two factors that affect energy consumption. Assuming that FDI causes economic expansion, higher incomes would have an effect on energy use (Lee 2013). Conversely, in generally better industrialized nations, this link might work in the other direction: as the economy expands, energy usage is anticipated to become more efficient, and FDI can aid in achieving this goal (Kivyiro and Arminen 2014). Therefore, energy consumption is a critical consideration in identifying the origins of carbon dioxide emissions.

1.2.0 Problem statement

Developed nations focus in clean industry goods. They're exporting pollutants to underdeveloped nations. This is the least encouraging scenario since it implies that healthier ecosystems in wealthy nations come at the cost of dirtier conditions in poorer countries. (2007) Poor economic growth has caused carbon emissions by relying on aging cars and filthy fuels. Vehicles that don't satisfy criteria are periodically inspected in certain industrialized nations. Old, toxic automobiles that cannot be utilized in those nations are occasionally transferred to underdeveloped countries without observing societal norms or examinations. Cleaner fuels and cars have been demonstrated to provide $40 in health and economic advantages for every $1 spent. (2009 African review) Firms that generate products and services utilizing economic resources like materials and energy release trash into the environment.

Sierra Leone's composite GHG emissions are high due to chemical fertilizers, manure application, and soil reintroduction of agricultural wastes. (UNDP,2011). Poor weather and market conditions aggravated power demand restoration in 2021, leading to higher coal burning despite renewable energy output reaching its greatest level ever.

In 2010, 38% of the country's rural population resided on degraded arable land, rising to 48 % in 2020. (Ministry of Agriculture rural population report). Depriving people of basic services like food and water may lead to poverty. The number of persons living in remote, deteriorating rural regions with little urban market penetration increased by 58% to 82 thousand between 2010 and 2020. Rural property ownership and socioeconomic opportunities are restricted for remote communities. Only 10% – 12% of urban Sierra Leoneans and 2% of rural residents have power. Gasoline or diesel generators are employed in most places since public electricity is inadequate. Kerosene, electric lights, and candles supply most lighting. 95.3% cook using fuel or charcoal.

Sustainable energy data are hard to find. Despite conventional thermal energy consumption and production patterns, Sierra Leone's power condition is not integrated. IRENA's "Renewable Energy Statistics 2017" report also states that Sierra Leone's solar power capacity is 0MW.

The release of greenhouse gases is a direct effect of burning fossil fuels to generate electricity, and it is commonly regarded as a major ecological concern humanity faces. Increases in the use of fossil fuels like gasoline and coal lead to a greater release of carbon dioxide into the atmosphere, which in turn raises global temperatures (IPCC, 2008). According to Acaravc and Ztürk (2010), carbon dioxide is the single most consequential gas released by human activities and a major contributor to global warming. Scientists have spent the past two decades studying environmental decline, increased temperatures, and climatic shifts. Rising sea levels, changed precipitation and snow patterns, melting ice, harsh weather, and the spread of disease are all consequences of global warming. The most important pieces of legislation to date in response to this environmental calamity are UNFCCC adopted in 1994 and the Kyoto Protocol (KP) established in 2005. (IPPC, 2008). Within this framework, nations are responsible for carrying out their pledges to combat climate change and reduce greenhouse gas emissions.

Products from the green sector are becoming more important to developed economies. These industrialized nations are effectively transferring their pollution to developing ones. This is the less hopeful picture, since it suggests that rich countries' comparatively pristine environments come at the expense of worsening circumstances in impoverished countries. For this reason (Brian, 2007) least developed countries contribute to rising CO2 emissions by copying the manufacturing methods of industrialized nations.

Increased use of older vehicles and more polluting fuels has contributed to air pollution, which in turn has worsened the region's already precarious socioeconomic growth. Vehicles in many countries, particularly the industrialized ones, are subject to frequent inspections to weed out the ones that don't pass muster. Automobiles that are too old to be driven legally in the developed world are periodically sent to countries like Sierra Leone, where there are less safeguards in place.

According to studies, developing countries risked being used as a dumping ground for undesired automobiles with greater emissions of greenhouse gases as developed nations invested money in renewable energy. Report on the Status of Africa in 2009

Businesses that create products and services using economic resources like materials and energy, with part of the input used returning to the environment as waste. Pollutants and their indirect costs include, but are not limited to, exhaust fumes, carbon dioxide, hydrogen sulfide, sewage sludge, and wastewater (Hamid Amadeh and Parisa Kafi 2015). Because all economic activity requires energy, it is often seen as a driving force behind economic growth and an improvement in living standards.

The Climate Analysis Indicators Tool (CAIT) at the World Resources Institute (WRI), 51.3 percent of Sierra Leone's total GHG emissions in 2019 would come from the country's land-use change and forestry (LUCF) sector. Ninety-five per cent of the LUCF sector's emissions came from changes in forest cover. About half of all emissions come from rice farming and animal enteric fermentation, making agriculture the second greatest source of emissions (25.7 percent). Total emissions were made up of 21.0% waste and 2.0% IP.

There is a draft version of Sierra Leone's energy policy plan up for public review and feedback. Included are measures that will facilitate domestic emission reductions mostly by 2035. To fulfill the promises, the suggested steps will build upon ongoing efforts. The BAU projection for emissions is 6.6 MtCO2e in 2030. Not included are efforts made to get resources upstream. The Bumbuna Dam successfully used one of about 20 places in Sierra Leone that had hydro potential. The finished Bumbuna dam can produce 70 megawatts of electricity. This was determined to be the most workable kind of mitigation for the electricity sector. Bumbuna is only one of five hydro potentials that might be harnessed to generate electricity in a way that would almost eliminate emissions.

The vast majority of emission-increase and -remediation-possibilities are attributable to the building sector, which has a gross reduction capacity of 1.2 Mt CO2e. In addition, the cement sector has emphasized a number of major mitigation methods, including increased use of efficient biomass (such as agricultural leftovers), energy saving technology, and combined heat and power. (UNDP,2011)

Emissions of carbon dioxide are often blamed as the root cause of climate change. As a major contributor to atmospheric CO_2 concentrations, carbon dioxide is a major contributor to the total quantity of greenhouse gases. In light of this, it is essential for academics in today's fast-paced world to determine the connection between economic growth and carbon dioxide emissions.

1.3.0 Significance of The Study

Although foreign direct investment (FDI), income, and energy consumption all seem to be essential in explaining CO_2 emissions, many academic studies simply examine the link involving two variables (e.g., EKC, pollution haven hypothesis). Thus, this thesis will investigate the following question:

How do foreign direct investment, income, urbanization, and energy use impact CO_2 emissions?

This study will aid both the scientific community and government officials in their fight against climate change. Foreign direct investment (FDI), for instance, is vital in both economic expansion and sound public policy (Lee 2013). For this reason, understanding whether or not FDI is linked to increased CO2 emissions is important for mitigating this trend.

Since CO2 emissions are identified as the primary factor behind global warming (Baek and Choi 2017), they will serve as the primary target of this thesis as an indication of environmental pollution.

In addition, CO2 emissions from industrial operations and fossil fuel burning are responsible for 78% of the rise in GHG emissions from 1970 to 2010. (IPCC 2014). Moreover, CO2 emissions strongly correlate with other damaging emissions as those of nitrogen oxide and Sulphur dioxide. Hence, it is extremely probable that a similar connection holds for other pollutants when considering the parameters in respect to CO2 emissions.

The overarching purpose of this research is to look at how rising economic activity contributes to environmental deterioration, with a special emphasis on carbon emissions. In order to perform their study, scientists relied on a model called the Environmental Kuznets Curve (EKC). This theory postulates that there is a reverse U-shaped relationship between per capita income and environmental quality. In order to infer environmental conditions, this research substituted CO2 emissions. The fast development of globalization is a significant component in this study's effort to look at the connection between economic growth and environmental damage. Despite the apparent inverted U-shaped link between growing income and greater carbon emissions, the nature of this relationship becomes less clear when considering changes in forest covering, as was revealed in the research. While earlier results have been confirmed, including globalization in the study reveals a correlation between increasing globalization and deterioration of the natural environment. This study will aid both the scientific community and government officials in their fight against climate change. Foreign direct investment (FDI), for instance, is a crucial factor in expansion and in decision-making (Lee 2013). For this reason, understanding whether or not FDI, economic growth, urbanization and energy consumption is linked to increased CO2 emissions is important for mitigating this trend.

1.4.0 Objective of The Study

The study's primary aim was to evaluate the causal dynamics between CO2emission, economic growth, urbanization, energy consumption, and FDI.

Specific objectives

- The goal of this research is to establish whether or not there is a correlation between the rate of energy use, carbon dioxide emissions, GDP growth, and FDI.
- That Sierra Leone's CO2 emissions have been increasing over time.
- To demonstrate the link between carbon dioxide emission and FDI.

1.5.0 Hypothesis of The Study

H1: GDP and FDI have significant positive effect on CO2 emissions

H2: FDI, economic growth, CO2 emissions and energy consumption exhibit causal relationships with each other in Sierra Leone.

1.6.0 Limitation of The Study

Some of the potentially useful control variables were unavailable online, and attempts to get them via other means were fruitless. This limited the study's ability to generalize its findings. Nonetheless, the results of the tests demonstrated the validity of the study's selection of variables and the strength of the technique used.

CHAPTER II

2.1.0 The Sierra Leone Economy

Having a wide variety of valuable natural resources, including diamonds, bauxite, iron ore, huge agricultural area, tourist attractions, and aquatic life, Sierra Leone had gained international recognition by the 1960s. In the 1960s, agricultural output, mining activity, GDP grew by 4% due to a stable currency in the financial market, rising exports, and a substantial currency buffer (Sierra Leone economic record, 2010). The decline in GDP during the late 1970s was around 1.6%, with the shutdown of the Marampa mine (a major mining operation) and oil price disruptions (which led to severe inflation and a devaluation of the Leone) being two major contributors. The decade of the 1980s was marked by a further slowdown in economic development and the instability of macroeconomic forces caused by the absence of national contingency planning. National revenue was negative to GDP, the country's per capita income was poor, and more than three-quarters of the population was poor. The government launched a number of failed economic policies in an attempt to reverse the decline. With a low point in 1986 of US$-140.3 million, FDI net inflow fell steadily throughout the decade of the 1980s. Local currency reserves have been falling as inflation has been rising. More than half the population was displaced when a civil war broke out in the 1990's and lasted for about a decade. This conflict was precipitated by the mishandling of state riches and poor or ineffective government. Many lives were lost, homes were destroyed, public and private utilities were disrupted, farms were abandoned, illicit extraction of the country's natural resources was conducted, and factories and service businesses were wiped out as a direct consequence of the civil war. The economy suffered as a result of all of these factors during the 1990s and 2000s.

It all began in the southeast, near the Liberian border, in March of 1991. The mining industry came to a standstill and farmland was left untended. And thus, by 1992's conclusion, the country's GDP had fallen by 19%, the Leone had continued to devalue against the US dollar and other foreign currencies, and the nation's currency reserve had become negative. Gross domestic product per capita fell from US$180 in 1992 to US$151 in 1999, the lowest three years in the country's history. Both exports and imports were very unstable throughout this era, with exports dropping from US$197.4 million in 1992 to US$28.6 million in 1999 and imports hitting an all-time low of US$79.8 million in 1999.

Depreciation of the country's currency was mostly attributed to the country's reliance on the sale of iron ore and other commodities to create foreign currency, which was severely impacted by the reduction in the price of iron ore. Sierra Leone's economy increased by 15.18% in 2012 and expanded by 20.7% in 2013 as the global economy began to recover from the financial crisis. However, the nation's GDP shrank to 4.56 percent that year, and a further 20.49 percent the next year as a result of the terrible Ebola virus that year, which killed approximately more than 4,000 people throughout the country. Following 2001's high of 73.55%, inflation dropped to 2014's low of 1.79%, before rising to 2015's final rate of 19.63

In 2012, Sierra Leone's GDP increased by double digits, reaching 15.8%, thanks in large part to a surge in the country's iron ore exports and the government's spending on infrastructure and agricultural subsidies. Although this growth rate was hindered by the fall in price of iron ore and the emergence of Ebola Virus in 2014, the International Monetary Fund forecast a $4.369 trillion Nominal Gross Domestic Product for 2016. With the aid of the international community, the economy swiftly rebounded from the drop in iron ore prices and the end of the Ebola outbreak. The real GDP rebound rate increased from -21.1% in 2015 to 6.06% in 2016, indicating a stronger economic performance. Less reliant on iron ore mining, Sierra Leone is shifting its focus to agricultural finance and expansion, infrastructure development, the tourist sector, and the fishing industry, making it one of Africa's most important nations for economic potential.

2.2.0 Foreign Direct Investment in Sierra Leone

Although it possesses a wealth of natural resources (including gold, diamonds, bauxite, iron ore, etc.), Sierra Leone has attracted very little FDI since gaining independence from the British in 1961. Causes include political instability (such as the civil war that ravaged the region in the 1990s) and societal and economic challenges. Although it sends out very little foreign direct investment, Sierra Leone has attracted money from all around the world. The country had a steady net inflow of FDI throughout the 1970s, with the amount rising from roughly US$8.6 million in 1970 to nearly twofold of that by the end of 1979 (US$16.3 million). This influx did not correspond with a rise in GDP as a proportion of total expenditures (1.89 percent in 1970, 1.45 percent in 1979). While the nation received about $323,000,000 in FDI Stock that year, the net inflow was a negative $-18,600,000 by year's end. Furthermore, by 1986's closing, this deficit net inflow had ballooned to $-140 million (about 28.62% of GDP). However, the nation was still capable of sustaining a positive net inflow of US$32.4 million (4.99% of GDP) by 1990, despite the fact that it had only attracted FDI inflow throughout the 1980s. This shift resulted from investors finding suitable investments for their cash, as well as a decrease in the outflow of capital or the shutdown of existing businesses. It was unexpected to learn that the country's stock of foreign direct investment (FDI) remained relatively stable at about US$240 million throughout the 1990s (around 0.5% of GDP).

There was a dramatic rise in foreign direct investment (FDI) net inflow from roughly US$39 million in 2000 to US$238 million (9.11% of GDP) in 2010 as a result of the country's success in attracting investment in the mining, agricultural, and infrastructure sectors after the conflict. Table 1 below displays data on FDI in monetary terms in the millions of US dollars. Between 2010 and 2016, the stock of foreign direct investment (FDI) rose from US$1,361 billion to US$2,108.4 billion. Financial institutions, infrastructure, and the service industry all grew rapidly during this era. Foreign direct investment (FDI) net inflow was roughly 32.3% of GDP by the end of 2011, after experiencing some negative impacts during the global financial crisis in 2008. The 2014 Ebola pandemic had a significant impact on economic development and FDI inflow, with the lowest FDI inbound (stock) and net inflows to the nation since 2010. FDI net inflow and Inward stock around US$510 million and US$2.108 billion at the end of 2016, as projected, both set new records as the country swiftly recovered to high levels.

The new investment policy guarantees the transfer of profits and the sale of assets, and the country's large mineral reserves make it an appealing location for foreign direct investment. Some of the primary obstacles to maintaining foreign investment in the nation include a delayed in the judiciary system in company establishment, a higher level of corruption, a lack of infrastructure, political violence and societal discontent owing to socio-economic upheavals, and a shortage of trained workers. Due to these challenges, the

World Bank ranks Sierra Leone at #148 out of 190 countries in its "Doing Business" report (2017).

2.3.0 Sierra Leone Energy Characteristics

Only around 10% to 12% of the urban population and about 2% of the rural population have access to electricity in Sierra Leone. Because most areas lack a reliable public power source, people often resort to using petrol or diesel generators. Light is often provided by kerosene, battery lights, or candles. Approximately 96% of the population relies on wood or charcoal from open fires for their daily cooking needs. Possibility for the usage of renewable energy sources is high, especially solar and hydroelectricity.

Specifically for renewable energy, figures on energy use in Sierra Leone are elusive. There is no comprehensive collection of data for Sierra Leone's Energy status, however the traditional thermal energy production and consumption trends have been documented.

This is borne up by international publications, such as IRENA's "Renewable Energy Statistics 2017," which states that Sierra Leone's solar power capacity is zero megawatts. Although EnDev and the Ministry of Energy in Sierra Leone have signed a memorandum of understanding (MoU) to collaborate on data collecting, getting statistics is challenging since diverse private sector parties are hesitant to provide data. There are less than 150 MW of operating capacity and around 150,000 connected consumers in Sierra Leone's power industry. About 40% of the population of Sierra Leone is serviced by the 161kv line that reaches to Freetown and the neighboring Western Area. Bumbuna hydro power plant, some 220 kilometers from Freetown, supplies the electricity.

The primary hub is Makeni, a town in the Port Loko District, is serviced by the Makeni grid. The Bumbuna hydropower station is also a contributor to the electricity supply.

Bo and Kenema, capitals of the Bo and Kenema Districts, respectively, in the southeast of the nation, are connected by the 33kv power line, also known as the Bo-Kenema line.

2.4.0 Hydro Power in Sierra Leone

Several rivers in Sierra Leone might be used to generate hydroelectricity, making this option a promising one for the country's energy needs.

The German Federal Ministry of Economics and Energy estimates that 2,000 MW can be generated via hydropower. Sierra Leone Republic Fact Sheet. There is potential for 2,000MW of hydropower, according the German Federal Ministry of Economics and Energy. Sierra Leone Fact Sheet, Official State Publication the Power Sector Master Plan (1996), a more hopeful study, identifies 27 prospective hydropower sites with a total capacity of 1,513 MW. In addition, UNIDO completed a study (Hydropower Potentials in Sierra Leone, UNIDO, 2013) that places the country's total generation capacity at 5,000 MW across 300 sites.

However, most of the rest are hampered by seasonal changes in water flow rate. The most cost-effective options for producing electricity include Yiben II, Bekongor III, Kambatibo, Betmai III, Yiben I, and Bumbuna Falls. Moreover, the vast majority of these hydropower sources have yet to be fully used. There is potential for tiny to mini-hydro systems, even though many of the rivers studied fall within the small to medium hydro system (i.e. 1 - 100 MW) (5 kW to 1MW).

Public-private partnerships and expanded private investment are seen as having substantial promise with resources under 2 MW. When it comes to producing energy, Sierra Leone has relied heavily on hydropower. Hydropower now accounts for 59% of all energy production capacity linked to the grid. Energy Policy of SL FINAL for Print.pdf was used for research. Sierra Leone's Policy on Renewable Energy

Sierra Leone's installed hydro power capacity is 56 MW as of 2017, according IRENA's "Renewable Energy Statistics 2017" report.

The largest hydro power plant in Sierra Leone is located in Bumbuna, Tonkolili District. It was commissioned in 2009 and has a 161kv transmission line and a 250km line length between Bumbuna and Freetown, providing electricity to around 40% of the city's people. The Bumbuna hydro power plant produces around 30–40MW during the rainy season and only 10–18MW during the dry season, resulting in frequent power outages throughout the months of February–April. The Bumbuna reservoir is shown on the five thousand Leones note, demonstrating the significance of the hydro power facility. The

Bumbuna plant also supplies energy to the city of Makeni. After much debate, the parliament of Sierra Leone finally passed "Bumbuna II" at the year's end of 2017. This project is an expansion of Bumbuna I and will add 143 MW to the country's power supply.

The president inaugurated the Bankasoka Hydro Dam in Port Loko town in December 2017, and along with the Makali and Charlotte dams it will generate around 5 MW of electricity. The Bankasoka (3MW), Charlotte (3MW), and Makali (120KW) power plants were all built and wired with assistance from the GoSL and the Chinese government in collaboration with UNIDO. The 3.4MW Guma plant in the Western Area was built in 1967 but was shut down in 1982.

2.5.0 Solar Energy in Sierra Leone

The "Energy Africa Policy Compact," an agreement between the United Kingdom and Africa, was signed by Sierra Leone in February 2017. After the agreement was signed, the Energy Revolution initiative was launched with the goal of providing cutting-edge energy solutions to 300,000 homes by 2018. The importance of solar energy and other renewable sources of power was brought to the forefront by a government response team and the business community. The International Renewable Energy Agency's "Clean Energy Data 2017" study claims that Sierra Leone has no solar power capacity. Several large-scale initiatives were wrapped up between 2014 and 2018.

In support of Community Growth via Renewable Energy Service Promotion: SHS installations for about 150 charging stations, 40 energy hubs for Agricultural Business Centers, 30 clinics, 18 schools, and 12 institutions providing financial services, three solar mini-grids were installed and run in the communities of Segbwema, Panguma, and Gbinti. In conjunction with Polytechnics, equip three Energy Laboratories with the necessary tools and education. Retailer distribution for the sale of Pico PV products. European Union, World Hunger Relief, Cooperazione Internationale, Energy for Opportunity, and Oxfam are all partners in this endeavor.

50 smaller mini-grids (6-36KW) and 40 larger mini-grids (>36KW) will be installed at healthcare institutions as part of the Rural Renewable Energy Project (2017-2020). The evolution of the business model for privately held enterprises. UNOPS and UK Aid are among the organization's partners.

The Ministry of Energy in Sierra Leone built 8,471 solar street lights throughout the country's fourteen district capitals. In 2017, the buildings were turned over to the respective regional, municipal, and municipal governments.

Since 2003, the Ministry of Health has been using about 900 solar powered fridges given by UNICEF to child immunizations throughout the country as part of the Expanded Programme on Immunization. Refrigerant replacement is presently underway.

2.6.0 Biomass for Cooking

A whopping 96.8% of Sierra Leoneans uses traditional means of cooking in their kitchens every day, according the 2015 Population and Housing Census. The remaining 3.2% comes from other energy sources like gas, kerosene, or electricity. Nationally, 64.7% of families rely on firewood, while 32.1% turn to charcoal. Each region has a different proportion. On average throughout the three areas (Northern, Eastern, and Southern), 83.7% of people use firewood and 14.5% use charcoal. In the Western Region, charcoal is used by 79.2% of households, wood by 6.7%, and other sources by 8.2%. To sum up, firewood is used mostly for cooking in rural regions, whereas charcoal is used predominantly in urban areas, notably in Freetown. The traditional 3-stone fire used by households who cook over wood. The 3-stone fireplaces are being substituted in urban areas of Sierra Leone with clay stoves and metal coal pots. Notably, though, 3-stone-fires continue to play an essential role even in metropolitan centers, since they are often used for the preparation of food that requires more time (such as food for celebrations) to be cooked.

The most common kind of outdoor "3-stone-fire" cooking wastes a lot of wood and contributes significantly to the shortage of firewood. Desert expansion, soil erosion, and depletion of soil fertility have become major issues since the pace of fuelwood consumption much surpasses the rate at which it is replenished. The country's 2.63 million hectares of forestry and wildlife protections are in danger of being destroyed in as little as 80 years if they are not properly managed. These would have disastrous effects on the ecosystem, including soil erosion, desertification, biodiversity loss, changes to local climate, and floods. The majority of these effects are already visible in various ecological zones around the nation, and they amount to enormous economic losses.

The private sector in Sierra Leone is responsible for all aspects of wood fuel production, distribution, and retail sales. Wood fuel is the most popular and cost-effective fuel option. Sierra Leone does not have a centralized agency charged with establishing market prices for wood fuels. Many people in urban centers use clay stoves made locally since they are more efficient at conserving fuel than the traditional metal charcoal burners currently in use in many West African countries. Nonetheless, further research into Advanced Cook Stoves is needed. In a Freetown factory made of clay and metal, Westwind Energy manufactures the "Wonder Stove." Following evaluations by EnDev, it meets all requirements for Enhanced Cook Stoves.

2.7.0 Urbanization

Over the last 50 years, Sierra Leone has followed the rest of African Continent in undergoing rapid urban growth as a growing percentage of the population makes their homes in the cities. More and more people are moving into urban areas, which are defined as communities with a population of 2,000 or more. This trend is known as urbanization.

Migration from rural to urban regions is a major contributor to this trend. In 1963, 412,254 individuals, or 18.9 % of Sierra Leone's urban population, lived in communities with a population of 2,000 or more (Makannah, 1986). More than 750,000 people now live in urban areas according to Statistics Sierra Leone (2006), up from 27.5 percent in 1974 (Makannah, 1986). In 2015, almost 3 million individuals in Sierra Leone called a city home, accounting for 40.9% of the country's overall population. As more and more people move into metropolitan areas, cities face rising strain that leads to less-than-ideal living conditions, environmental deterioration, insufficient infrastructure, and a rise in crime.

The Western Region, which contains the nation's capital and the largest city in Sierra Leone, Freetown, is almost totally urbanized, as determined by a study of regional urbanization by household population. It's also worth noting that, outside of the District of Columbia, no other area in the country has a higher urbanization rate.

Of the country's 14 districts, three have urbanization rates that are greater than the national average. They were the Western Area Urban (100%), the Western Area Rural (90.2%), both in the Western Region, and the Kenema District (44.5%) in the Eastern

Region. Most of the other districts have urbanization rates that are lower than the national average, with the Southern Region having the lowest urbanization rates overall. Moyamba and Pujehun were the two districts, with urbanization rates of 7.1% and 8.1%, respectively. Differences across the country's regions and districts are starkly reflected in the country's urbanization rate. About 36.3% of the people lived in urban areas throughout the nation, with the remaining 13.8% living in rural areas. This proportion was highest in the Western Region. Kenema District was the most urbanized in the Eastern Region, accounting for 9.4 percent of the country's total urban population. Bombali had the greatest urbanization rate in the Northern Region, yet it only accounted for 6% of the urban inhabitants in the whole nation. The southern part of the country has the fewest people living in cities. With the exception of Bo District (6.7% of the national total), no Southern Region district registered more than 2% of the urban population in the country.

CHAPTER III

3.1.0 Theoretical Literature Review

Why should we look at how FDI, wealth, and energy use are related to a pollutant like CO2? To begin, Kim (2019) pollutant haven and halo ideas, and the Environmental Kuznets Curve have all been examined extensively over the last two decades, the author argue. The first study looks at GDP and pollution levels, while the other two examine FDI and pollution levels (Kim 2019). In addition, there is a lot of research on how energy consumption affects GDP growth and how energy production affects air pollution (Zhu et al. 2016). As all trio appear to be important in determining what motivates CO2 emissions, they need to be examined together to acquire a full picture of their dynamic. This chapter provides a summary of the most fundamental ideas and hypotheses that have been proposed to explain these connections in the academic literature. The effects of size, composition, and technique are first discussed in this chapter. Second, a quick explanation of comparative advantage is provided. After that, we'll talk about how factors like FDI, income, and energy all affect emissions. Pollution haven theory, the pollution halo hypothesis, and the environmental Kuznets curve, three of the most well-known ideas of the interrelationships among the variables, will be used to explain their significance. All across the chapter, we wonder whether there aren't any more factors that should be considered, and we'll talk about those factors and why they're important later on.

According to Grossman (1995), the quantity of emissions from manufacturing activities is determined by three different impacts. There are three types of effects: scale, composition, and method. At first glance, it may seem that more consumption and manufacturing would lead to more pollution as well as a decrease in the Global resources. Grossman (1995) argues, notwithstanding, that "Growth can proceed to maintain even better standards of living without jeopardizing the inconsequential components of human wellbeing if it is accompanied by a change in the structural system of the financial system and the modification of greener and resource- sustaining techniques for creepier, asset technology solutions.. Here, Grossman is discussing the impact of composition and technique. An initial argument may be that the scale effect guarantees a proportional increase in pollution alongside a rise in production, everything else being equal. Composition and technique, however, may have an even greater impact. Increases in the proportion of GDP attributable to greener manufacturing operations lead to lower emissions due to the composition effect. Changing from an industrial to a service economy results in less pollution, as seen in Figure 1's composition effect. The composition effect may have a deleterious impact on air quality in certain cases. Tsurumi and Managi (2010) argue that the shift from, example, an agrarian predominant economy to an industrialized one is likely to impact the environment because of the increased need for energy. When a result of the technique effect, emissions should decrease as unclean polluting technologies are phased out and replaced with cleaner alternatives. This occurs, for instance, as a result of technological progress or governmental rules and regulations (Grossman 1995).

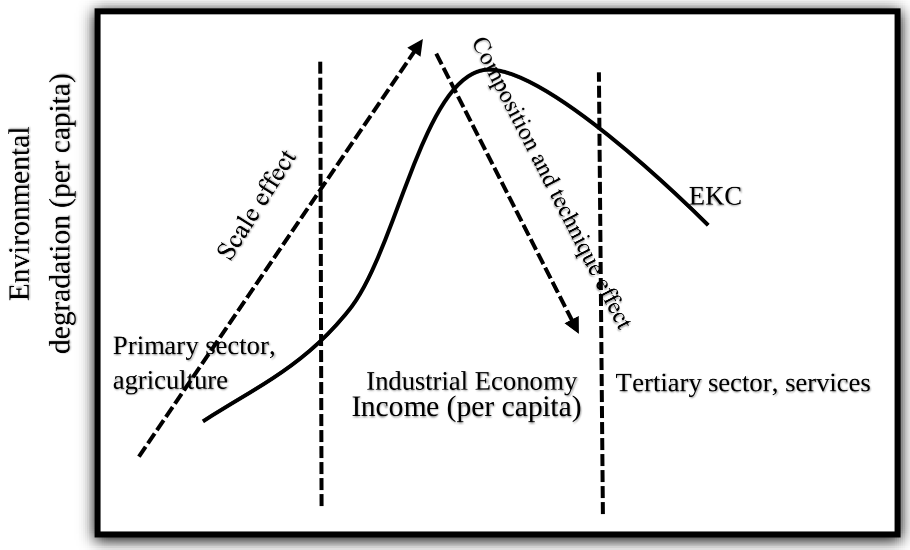

Figure 1: EKC with all three effect (kaika and zervas 2013)

Comparative benefits will be discussed and explained in the following sections. As a tenet of neo-classical trade theory, comparative advantages have been around for a while. David Ricardo, according to Muradian and Martinez-Alier (2001), was the first to demonstrate that trading between nations might result in mutual benefit. The absence of an absolute advantage in the production of a thing does not exclude a country from benefiting from international commerce. The Heckscher-Ohlin theory is the foundation of modern physics. According to Heckscher-Ohlin's a nation has a comparative advantage due to the high quality of its available productive assets. That is, a nation will manufacture products in sectors where its production elements (such as technology and money) are most plentiful. Having a trading relationship in this instance would benefit both nations. Emission nations, as described by Kohn (1998), are those having an abundance of resources necessary for the manufacturing of polluting products. In conclusion, any nation may benefit from trade since every nation has some kind of comparative advantage in manufacturing some kind of item or service.

3.3.0 Fdi, Income and Energy Consumption

When examining the factors that contribute to CO2 emissions, three factors stand out as particularly significant. According to the review, "based on historical research, we conclude that energy consumption, FDI, and economic development are the key predictors of CO2 emissions, although their influence on CO2 emissions remains contentious (Tang and Tan, 2015).

Economic development and energy use are the two most significant factors affecting quality of the environment, as confirmed by Zhu et al. (2016). The subject of FDI's impact on the environment is further prompted by the growing tides of FDI into emerging economies (Zhu et al. 2016). This triangular set of factors, however, is further complex by their interdependence on one another.

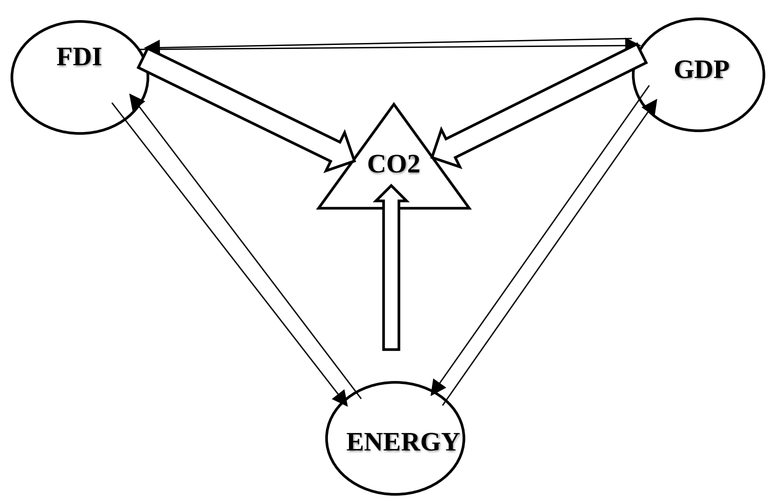

Figure 2: FDI-INCOME-ENERGY-CO2 RELATIONSHIP

3.4.0 Foreign Direct Investment

First among the variables that are connected to environmental contamination is something called foreign direct investment (FDI).

There are two hypotheses that attempt to explain how foreign direct investment (FDI) affects the state of the environment. However, according to the Lucas paradox, it is impossible for either of these hypotheses to be accurate since foreign direct investment typically goes from less industrialized to more developed nations.

3.5.0 Pollution Haven Hypothesis

Polluting companies, according to the pollution haven hypothesis, relocate to developing countries because of laxer environmental restrictions in the former (Levinson and Taylor 2008). Zhu et al. (2006) argue that countries' lack of concern for ecological challenges and consequent inability to enact (enforce) regulatory requirements for ecological sustainability gives emerging economies a comparative advantage in polluting production due to the disparity in the strictness of environmental legislation between the two. Therefore, due to the competitive advantage for polluting production afforded by the inadequate environmental rules in underdeveloped nations, additional polluting production will move there. Therefore, foreign direct investment and carbon dioxide emissions are expected to have an inverse connection, as predicted by the pollution haven hypothesis (Zhu et al. 2016). Kim (2019) says that wealthy economies are obligated to lower more GHG emissions and thus should, as a result, limit their polluting operations, which exacerbates this effect. As a result, there is an increase in the trend of moving these pursuits to poorer nations.

In addition to the pollution haven theory, (Sarkodie and Strezov (2019) bring up the larger concept of the displacement impact. This implies that corporations that create a lot of pollution will relocate to nations with laxer environmental rules and lower production costs (Sarkodie and Strezov 2019). The 'race to the bottom' phenomena can also lend support to the 'pollution haven' idea. Which indicates that nations are trying to gain a competitive edge by lowering its regulatory laws in order to attract businesses (Porter 1999).

The time may come when this edge is no longer advantageous. Poor countries have the option of adopting more stringent environmental rules. Since FDI appears to boost income, and existing studies indicate that environmental rules get more rigorous as income rises, this may be the case (He 2006). This means that increased FDI will lead to stricter environmental restrictions in emerging countries. The technique impact describes how more environmental regulation can result in a more resource- and energy-efficient manufacturing process that benefits society as a whole (He 2006). Environmental rules in some countries may be laxer than those in others, giving those countries a competitive advantage.

3.6.0 Pollution Halo Hypothesis

In order to help the environment, the pollution halo concept suggests that FDI can help. This is because of the "technical impact," or the reduction in pollution brought about by the widespread adoption of modern, environmentally friendly manufacturing methods by "FDI firms," or businesses operating in the nation (Zhang and Zhou 2016).

He (2006) discusses that in addition to the reasons given by the pollution halo hypothesis, local governments in the host country may feel compelled in making their manufacturing processes more efficient so they can compete with foreign conglomerates. This will encourage increased creativity and productivity (He 2006). Similarly, when FDI is channeled towards the service industry, emissions might be reduced.

Advancement, according to the Porter hypothesis, may also have a beneficial effect on decarbonization. Foreign direct investment is not the driving force behind cost-cutting innovations; rather, it is restrictions (Levinson and Taylor 2008). Therefore, if we consider just the industrialized nations, which having stricter laws, there are incentives to innovate. These breakthroughs reduce manufacturing costs, canceling out the advantage that emerging countries have over developed ones due to environmental rules that are more stringent in poorer nations. The term "innovation offsets" was coined by Porter and van der Linde (1995) to describe the potential benefits of new technologies that " may not only reduce the overall cost of complying with environmental rules, but also provide companies a competitive edge over those in countries without equivalent regulations".

3.7.0 Lucas Paradox

He (2006) questions the importance of environmental enforcement costs in determining FDI placement, as proposed by the pollution haven and halo hypothesis. In the context of China, for instance, foreign direct investment (FDI) flowed in initially because of the country's low labor costs. However, in the past few years, FDI has primarily been drawn to China in order to take advantage of the country's expanding domestic market and secure a top spot there (He 2006). This shows that China does not gain a competitive advantage from stricter environmental laws when it attracts foreign direct investment.

Capital transfers from developing to developed countries, according to Lucas (1990). The research of Alfaro et al. (2008) corroborates this interpretation. From 1970 to 2000, they demonstrate a greater inflow of capital per capita into high-income nations than low-income ones. Capital flows are affected not only by financial development and economic growth but also by human capital and asymmetric knowledge (Alfaro et al. 2008). That would disprove Lucas's (1990) pollution haven concept. Environmental restrictions' strictness will not be a key determinant in the flow of capital, but rather, other variables. Variability in basics that impact the manufacturing system of the economy (such as policy decisions, regulations), and defects in the capital market internationally (such as asymmetric knowledge), are the two categories into which Lucas (1990) divides the causes (Alfaro et al. 2008)

3.8.0 Income

Under this research, I argue that changes in environmental pollution are linked to increases in income, which I also reference to as GDP per capita. The environmental Kuznets curve is the most widely-accepted explanation for this correlation (EKC).

3.9.0 Environmental Kuznets Curve

The environmental Kuznets curve, popularized by a publication by Grossman and Krueger (1991), is a theory that proposes a correlation between per-capita wealth and environmental damage. A key assumption of this theory is that the interaction between these factors takes the form of a reversed U. (see Figure 1). That's why rising levels of individual wealth tend to be accompanied by escalating levels of pollution (i.e., the scale effect). As income rises, pollution levels decline, but only once a specific threshold is crossed.

The subject of environmental deterioration shows a monotonic increase followed by a monotonic drop. Policymakers must take this into account when they chart a nation's economy development trajectory. The steady worsening of the environment as a result of rising prosperity necessitates rigorous environmental restrictions. Accelerating economic expansion, as it does not demand explicit environmental policies and corresponds to swift environmental quality, is what is needed for a steady decline in environmental pollution. A slowdown in economic growth could have unintended consequences that hold back progress in environmental fields.

3.1.1 Energy Consumption

Beak (2016) emphasizes that past studies have shown that energy use affects the environment; hence, excluding it from studies of pollution will result in spurious regression and inaccurate conclusions.

A rise in energy consumption, for instance, is correlated with an increase in carbon dioxide emissions, as discovered by Zhu et al. (2016). Sarkodie and Strezov (2019) state that many nations' ever-increasing energy needs are met almost exclusively by fossil fuels. It should come as no surprise that higher energy usage correlates with higher CO2 emissions. Increasing energy efficiency, attracting greener technology, and modifying political systems are all essential to cutting CO2 emissions (Sarkodie and Strezov 2019). The world's largest ethanol producer is, for instance, Brazil. Since 1970, ethanol has been blended into gasoline, helping to lower the United States' carbon footprint (Pao and Tsai 2011). Switching from fossil fuels to green technologies while trying to keep operational costs down may be difficult for developing countries (Sarkodie and Strezov 2019). Remember that using renewable energy sources can have one set of effects on CO2 emissions, while using fossil fuels can have another.

3.1.2 Other Drivers of Co2 Emissions

CO2 emission ideas related to foreign direct investment, GDP, and energy use are explored at length in this chapter. Additional elements, though, may also be significant. Figure 3 highlights this by extending the correlations between previously mentioned factors. CO2 emissions may also be affected by the aforementioned outside factors. The Lucas paradox reveals that FDI flows and, by extension, CO2 emissions are also affected by variables like as macroeconomic performance. These further factors will be explored below.

3.1.3 Composition of The Economy

As we've seen in this chapter, the diversity of the economy is reflected in the composition effect. To that end, an economy with a greater emphasis on manufacturing may produce more pollution than one focused on service. The possible importance of this influence may be investigated by including a variable representing the structure of the economic system in the econometric analysis of this thesis. A rise in FDI and/or income increases CO2 emissions, but the quantity of emissions generated depends on how dirty the sector is; therefore, this variable would have a tangential influence on the number of emissions.

3.1.4 Trade Openness

The amount of carbon dioxide emissions may also be affected by the degree to which trade is liberalized. Higher levels of trade openness, can reduce CO2 emissions in all countries, but mainly in those with moderate and high emissions. Since this factor is important, they use it as a control. Size of the population, type of industry the economy is composed of, and the level of financial development are all used as controls to ensure that no important factors were overlooked. Shahbaz et al. (2017) also looked at how increased trade liberalization as well as GDP growth affected Greenhouse gasses. Because it boosts economic growth, freer trade appears to degrade environmental quality (Shahbaz et al. 2017). Some scholars, however, contend that freer trade can boost environmental quality as well by increasing resource efficiency, bolstering incorporation of environmental tools, and ensuring continued sustainable development (Shahbaz et al. 2017). Many papers, according to You et al. (2015), fail to account for the fact that certain factors—such as levels of democracy and financial openness—may vary across the spectrum of CO2 emissions. Research on the EKC frequently incorporates a political component, such as democracy, because of the latter's impact on the establishment of environmental policy norms within a country. Explaining institutional problems (as highlighted by Lucas (1990)) can be gleaned from knowing whether or not a country is a democracy. This is sometimes referred to as the "democracy-environmental pollution nexus" in the academic literature. However, the effects on the ecosystem are unclear. The third factor they consider is financial openness, which might increase pollution levels since an improvement in financial infrastructure can have a knock-on effect on technology's efficiency. This connection, however, is rarely studied (You et al 2015)

A study by Peters et al. (2007) on the causes of rising CO2 levels in China found that urbanization and behavioral shifts were to blame. The efficiency gains will be outweighed by the greater consumption and new infrastructure projects brought on by these factors (Peters et al. 2007). Improvements in consumption habits are a direct outcome of China's rising standard of living. While CO2 emissions rise during the development phase of most infrastructure projects, these levels fall as the economy matures and people begin to use the new facilities. CO2 emissions are also marginally affected by net trade (Peters et al. 2007). An empirical results of carbon dioxide emissions should, consequently, take into account whether or not shifting consumer habits and expanding infrastructure are relevant factors to analyze.

3.1.5 Population

Shi (2003) argues that rising populations are a major factor in climate change because they drive up carbon dioxide emissions. Energy must be expended to provide the needs of each individual in terms of food, water, shelter, and the like. In addition, population expansion can lead to shifts in land usage and an uptick in forestry degradation. As a result, CO2 emissions may rise (Shi 2003). Boserup (1981) counters these views by arguing that a growing population encourages technological advancement, particularly in agriculture. Which boosts productivity while keeping people's standard of living constant (Shi 2003). In this way, increasing populations are thought to trigger the technological impact and possibly result in reduced CO_2 emissions. As indicated by Peters et al. (2007), rapid population growth is often criticized because it increases demand for energy and other scarce resources, which has an adverse impact on the natural world . Other academics, however, suggest that the mounting environmental threats motivate innovative technology responses. Whether or whether this is true for developing countries, where issues like limited resources and property rights make it difficult to implement new technologies, remains to be seen (Shi 2003). So far, both sides of this debate have been supported by research (Shi 2003).

3.1.6 Economic Growth and Co2 Emission

Environmental economists have spent a lot of time and effort in recent years studying the correlation between economic growth and carbon emissions. According to the EKC theory, a country's pollution levels rise as its economy advances; at some point, the country's income will have climbed to a tipping point, at which point carbon emissions peak before dropping due to economic growth over a predetermined timeline. According to the EKC, pollution and economic prosperity go hand in hand. The EKC hypothesis was verified, showing that developed nations are becoming conscious of environmental damage and investing in green financing to develop renewable energy sources. The EKC theory has been supported by several investigations. Apergis and Ozturk (2015) provided evidence for the EKC hypothesis in this field by showing that carbon acid gas has an inverted U-shaped connection with GDP per capita. For the time period between 1960 and 2008, Narayan et al. (2016) used a cross-correlation estimation approach to look at the connection between economic development and carbon emissions for 181 nations, finding evidence in favor of the EKC hypothesis. The EKC hypothesis was validated for the BRICS countries. Evidence was found of a correlation between GDP growth and carbon dioxide emissions in 15 oil-producing countries between 1980 and 2010. From 2000 to 2018, Bibi and Jamil (2021) used the random effect and fixed effect panel estimates test to verify the EKC between GDP per capita and other key factors and carbon dioxide emissions in MENA areas. Furthermore, Sun et al. (2021) used the V.A.R., V.E.C.M., and Granger causality testing procedures to investigate the association between economic growth, renewable energy technologies, and carbon emissions in the Chinese setting during the period of 1990-2017. A reverse U-shaped correlation was found between economic growth and carbon emissions. According to the findings, using environmentally friendly technology is the most effective method for cutting down on greenhouse gas production. Using the ARDL model, Abumunshar et al. (2020) found that Turkey's level of carbon emissions increased as GDP increased between 1981 and 2015.

There are, however, contradictory results in the literature that are connected to the EKC theory. Between 1997 and 2011, researchers Chakravarty and Mandal (2016) examined the EKC hypothesis's predicted relationship between BRICS countries' per capita income and their carbon emissions using the fixed products and G.M.M. testing method. The results showed that the EKC was not reliable in the BRICS countries throughout the time period under review. In numerous European nations between 1980 and 2014, Dogan and Lotz (2020) looked into the EKC hypothesis's prediction that an economy's economic structure will have a direct impact on its carbon emissions. FMOLS, O.L.S., and the S.T.R.I.P.A.T. testing procedures were used by the authors. Analysis of actual data disproved the EKC theory. Finally, Aydn and Turan (2020) used the A.M.G. and C.C.E.M.G. testing models to investigate the impact of GDP growth, free trade, and energy intensity on carbon gas emissions from BRICS nations between 1996 and 2016. The empirical results did not confirm the existence of the EKC hypothesis across all BRICS countries. Several recent research have demonstrated that GDP has a strong influence

3.1.7 C02 Emission and Energy Consumption

The correlation between carbon emissions and energy consumption (from both renewable and nonrenewable sources) has been the subject of a great deal of research. As part of their research on this topic, Boluk and Mert (2015) looked into the possibility that the Environmental Kuznets Curve (EKC) hypothesis is correct by analyzing the effect of renewable energy usage on the decline of GHG emissions in Turkey between 1961 and 2010. According to the results, renewable energy consumption in Turkey resulted in lower Carbon footprint.

Greenhouse gas (GHG) emissions in Turkey were reduced from 1988 to 2018 and from 1981 to 2015, according to analyses by Altarhouni et al. (2021) and Qashou et al.

(2022) that used the A.R.D.L. framework. In a study spanning from 1992 to 2014, Ummalla and Goyari (2020) used FMOLS and the Dumitrescu-Hurlin panel causality test to verify the EKC hypothesis for the BRICS countries. The findings revealed that switching to sustainable energy greatly lowers carbon output. Quantile regressions estimate was used by Altinoz and Dogan (2021) on a panel of 82 nations between 1990 and 2014. The results showed that using renewable energy sources had a negative effect on carbon emissions. Furthermore, Aziz et al. (2021) used the novel Method of Moments quantile regression model and Dumitrescu-Hurlin causality test to examine the impacts of natural resources, renewable energy, and globalization on carbon emission according to the EKC in the MINT nations. Results confirmed the EKC hypothesis between income and carbon outflow, with the exception of higher quantiles, whereas renewable energy usage led to an increase in carbon outflow at above half quantiles and a decrease at below half quantiles. The study concluded that, between 1995 and 2018, the supply of electricity from renewable sources fell short of consumer demand.

3.1.8 Correlation between Urbanization, Energy Use, Carbon Emissions, and Foreign Direct Investment

This study looks at how FDI, GDP, urbanization, and energy use are all interconnected. On the other hand, there is substantial proof that the aforementioned factors connect with one another. Although exploring the full extent of this relationship is outside the scope of this thesis, it should be remembered that it exists. The Foreign Direct Investment–Income Nexus and the Income–Energy Nexus are so briefly described.

Foreign direct investment (FDI) and GDP growth appear to have mutually reinforced effects. The primary goal of governments' efforts to entice foreign direct investment (FDI) is to stimulate their economies' expansion (Lasmiraroj 2016). Take Vietnam as an example; FDI has been a major factor in that country's economic expansion (Tang and Tan, 2015). However, economic growth can also entice foreign direct investment (FDI), as it is linked to rising living standards and the promise of a significant consumer base. According to Lamsiraroj (2016), economic development is a factor that affects the amount of FDI inflows, alongside the size of the labor force, the existence or absence of trade sanctions, and a favorable investment environment. It appears that the connection between money and power can go both ways. A higher level of energy consumption is expected as a direct outcome of increased income levels due to the correlation between the two. The authors Ahmed and Azam (2016) call energy "the lifeblood of the growth process and 'oxygen' of the economy" (Ahmed and Azam 2016 p. 654). Since energy is a factor of production, it is clear that it is essential for economic development (Ahmed and Azam 2016). This is why they claim energy is essential for a flourishing economy.

3.1.9 Empirical Literature Review

With yearly data from 1980-2005, Nondo et al. (2010) analyzes the relationship involving energy use and GDP for 19 COMESA member nations. The panel stationarity test indicates that all data sets are integrated at first difference, and the panel cointegration test confirms that all data sets are cointegrated. Cointegrating bidirectional relationship involving GDP and energy demand, with the direction of causation moving from energy consumption to GDP, is the outcome of the panel error correction model for high-income COMESA nations.

Tiwari Aviral Kumar (2011) use a Vector Auto Regressive (VAR) paradigm to explore the correlations among India's energy consumption, CO2 emissions, and GDP growth. Their findings also show that while energy consumption affects CO2 emissions positively, it has a negative impact on India's population and economic development.

Carbon dioxide emissions and gross domestic product growth in a cross-section of wealthy nations are examined by Younes Nademi and Alie Asghar Salem (2011) using the EKC framework. The estimation findings demonstrate that the CO2 emissions of these nations increased in a nonlinear inverse Kuznets Curve-shaped pattern between the years 2000 and 2007. The results also show that GDP affects CO2 emissions adversely before the expected barrier is achieved and positively after the threshold is crossed. Their findings contradict EKC theory for these nations.

Research by Sharif Hossain (2012) investigates the dynamic causative link between carbon dioxide emissions, energy consumption, economic development, international trade, and urbanization using time-series information from 1960-2009. Using the ARDL estimation procedure and the granger causality test, we find that there is short-run unidirectional causality linking energy consumption and trade openness to carbon dioxide emissions, trade openness to energy consumption, carbon dioxide emissions to economic growth, and economic growth to trade openness. An extended period of time demonstrates a correlation between the variables, as shown by the long run bound test.

Granger causality testing is used by Jonathan P. Danladi and Kehinde John Akonolafe (2013) to look at the assertions that environmental degradation reduces economic development and FDI. As shown by their research, a correlation exists between the expansion rate of FDI and the rising rate of pollution in Nigeria, but not between the growth rates of GDP and CO2.

Using data collected between 1965 and 2010, Kuo Cheng et al. (2014) analyzes the correlation between Hong Kong's GDP, energy use, and carbon dioxide emissions. The Granger causality test and the VAR model both indicate that CO2 emissions and Hong Kong's GDP are related, and that CO2 emissions bring about a rise in Hong Kong's energy usage. It was also found that GDP and energy use are causally connected in both directions.

Dritsaki, C., and Dritsaki, M (2014) investigated the connection between energy consumption, economic development, and CO2 emissions within Portugal, Spain, and Greece between 1960 and 2009. In this research, they employ both a panel causality test and a panel cointegration estimation strategy.

The authors Cuma Bozkurt and Yusif Akan (2014) analyze the connection between GDP growth, CO2 emissions, and energy consumption in Turkey using annual time series data from 1960 to 2010. By utilizing the maximum likelihood (ML) technique created by Johansen (1988) and Johansen and Juselius (1989), they analyzed the data to see if the prices were cointegrated. The empirical result shows that emissions of carbon dioxide (CO2) hinder economic growth while energy use helps it.

Dinh L. Linh and Shin-mo Lin analyzed the dynamic relationship between carbon dioxide emissions, energy use, economic growth, and foreign direct investment in Vietnam from 1980 to 2010. (2014). The hypothesis under scrutiny is the environmental Kuznets curve Hypothesis. In order to determine which way, the associations are trending, they employ the cointegration test and the granger causality test. Their findings disprove EKC in Vietnam. However, the results of the Granger causality test show that CO2 emissions, energy consumption, foreign direct investment, and economic growth all have a dynamic relationship with one another. Their findings also show a symmetrical relationship between GDP growth and FDI inflow, lending credence to the hypothesis that a faster-growing economy will be better able to entice investors from abroad.

The nonlinear causal relationship between carbon dioxide (CO2) emissions, energy consumption, economic growth, and foreign direct investment in the most populous Asian nations is the subject of research by Dinh L. Linh and Shin mo-Lin (2015). The results validate the pollution haven hypothesis, which postulates that FDI inflows have been attracted to source nations with less stringent environmental regulations.

Botswana, Cameroon, Gabon, Ivory Coast, Kenya, Senegal, Togo, and South Africa are just some of the African countries Eleazar Zerbo (2015) examined using the ARDL bound test developed by Peseran, Shin, and Smith (2001). The study found that in Botswana, Kenya, South Africa, and Togo, reducing energy use reduced carbon dioxide emissions in the near term. Kenya's efforts to improve environmental quality are not significantly impacted by South Africa's push for more commercial openness.

Ahmed Saddan (2015) examines the per capita GDP, FDI inflows, and imports of the GCC countries of Bahrain, Saudi Arabia, Kuwait, and Oman to determine if there is a variance decomposition. In his study, he employs the Vector Error Correction Model to make estimates based on 256 data spanning the years 2000-2010. (VECM). The results of the estimation show that FDI has a considerable impact on GDP. The data also reveal that the GCC governments' refusal to acknowledge FDI and imports as having a negative impact on the environment is directly connected with an increase in atmospheric CO2 emissions.

Alfred A. Haug and Meltem Ucal, in their 2019 paper, look at how trade and FDI have affected carbon dioxide emissions in Turkey. They employ both the ARDL and NARDL Models to examine the asymmetric influence on exports, imports, and FDI Co2 emissions per capita. The results show that exports, imports, and FDI all have different impacts on CO2 per capita emissions. Results also reveal that while increasing exports does not significantly affect CO2 emissions, increasing imports does so over the long term. The results also provide credence to the environmental kuznet curve theory as applied to turkey.

GDP, trade integration, FDI inflows, GDI, and capital all contribute to lowering Nigeria's carbon emissions, as reported by Zubair et al. (2020). With the help of ARDL bound testing and enhanced Vector Auto Regressive estimate from 1980–2018, they draw conclusions. As suggested by the results of the bound tests, the variables do have a long-term correlation. The predicted result also shows that an increase in Nigeria's GDP, capital, and FDI inflows is statistically significant in cutting carbon dioxide emissions. A causality analysis reveals a two-way relationship between CO2 emissions and FDI inflows, but only a one-way association between capital and CO2 emissions.

In their analysis of BRICS countries, Ahmed Samour and Turgut Tursay (2022) use the EKC hypothesis and the pollution haven hypothesis to examine the connection between renewable energy, energy use, and carbon dioxide emissions. The researchers used the estimating strategy of moments quantiles regression (MMQR) in their investigation. The results of the empirical studies provide credence to the EKC theory as applied to the BRICS nations. Further, across all quantiles (1st–9th) of CO2 emissions, the coefficient for the consumption of regenerative energy is negative, indicating that regenerative energy and financial inclusion are useful methods to reduce CO2 emissions.

Using data from 1980 to 2019, Atikur Rahman, Afzal Hossain, and Song sheng Chen (2022) examine how foreign direct investment, tourism, energy consumption, and economic development affected Bangladesh's carbon dioxide emissions. In this study, the granger causality test and the error correction model of estimation were employed. Their research shows that FDI, energy use, and economic growth all have a substantial and beneficial long-term influence on CO2 emissions. The damage caused by tourists stays with them for a long time. In conclusion, their findings lend credence to the EKC theory in Bangladesh by demonstrating that the relationship between economic growth and CO2 emissions is U-shaped.

3.2.1 Synopsis of Literature Reviews

ARTICLE	RESEARCH QUESTION	DATA TYPE	METHOD(S)	OUTCOME
Zhu et al (2016)	Determine how foreign direct investment, economic expansion, and energy consumption affect CO2 emissions.	Panel data ASEAN-5 1998-2011	Quantile regression model	No evidence for EKC
You et al. (2016)	To examine whether nations with more democratic governments and more transparent financial systems have lower average emission rates, we may look at the top emitters and bottom emitters and compare them.	Panel data	Quantile regression method	Evidence for EKC
Pao and Tsai (2011)	In what ways may rising prosperity and	Panel data for BRIC	VECM model.	Evidence for EKC

	improved access to financial services contribute to environmental deterioration?	countries, 1980-2007		
Chandran and Tang (2013)	How does the transportation industry affect overall energy usage?	Time series data	VECM model	No evidence for EKC
Boutaba (2014)	Carbon emissions, monetary progress, and economic growth all seem to have a causal link, although the long-term equilibrium and the direction of this relationship are under investigation.	Time series data for India 1971-2008	ARDL approach.	Evidence for EKC
Baek (2016)	Co2 Emissions and Its Causes: The Role of Foreign Direct Investment,	Panel data	ARDL model	Evidence for EKC

	Income, and Energy Use			
Rafindadi (2018)	Considering the Impact of Energy Use and FDI Flows on Environmental Degradation	Panel data	ARDL model	Evidence for EKC
Mert and Boluk (2016)	FDI's effect on carbon dioxide emissions and the possibilities for using renewable energy sources to power homes and businesses	Panel data	ARDL	No evidence for EKC
Samour and Tursay (2022)	Examine the connection between renewable energy, energy use and carbon dioxide emission	Panel data for BRICS countries	Moment Quantile regression (MMQR)	Evidence for EKC
Chen et al	Examine how foreign direct investment, tourism, energy consumption, and economic	Time series data	Granger causality test and the error correction model	Evidence for EKC

	development affect Bangladesh's Carbon dioxide emissions			
Haug and Ucal (2019)	How trade and FDI have affected carbon dioxide emissions in Turkey	Time series data	ARDL and NARDL model	Evidence of EKC
Ahmed Saddan	Examine the per capita GDP, FDI inflows and imports of the GCC countries of Bahrain, Saudi Arabia, Kuwait and Oman to determine	Panel data	VECM	No evidence of EKC
Ummalla and Goyari (2020)	Verify the EKC hypothesis for the BRICS countries	Panel data	FMOLS and the Dumitresscu-Hurlin panel causality test	Evidence of EKC

Table 1: synopsis of literature review in this study

3.2.2 Conclusion

Reform to prevent climate change require research on the causes of CO2 emissions. Foreign direct investment (FDI), GDP, and energy use all appear to be significant factors, but their impact on CO_2 emissions remains unclear. This was influenced by the scale effect, the composition effect, and the technique impact. It appears that factors beyond the three primary explanatory variables contribute to this relationship. factors such as population size, institutional strength, and the make-up of the economy. While these factors do not always have a direct impact on CO_2 emissions. Consequently, it is essential to incorporate (at least some of) these variables into this study.

CHAPTER IV

4.1.0 Urbanization, Energy, and Economic Growth Concepts.

Especially for many nations in Africa and Asia, the rapid urbanization of the developing world poses a serious problem in the twenty-first century (Madlener and Sunak, 2011). In the coming 40 years, the urban population of emerging nations is projected to grow from 2.6 billion to 5.3 billion (Madlener and Sunak, 2011). Additionally, urbanization is projected to more than quadruple in the world's poorest nations, from 18% in 1950 to 67% in 2050 (Sadorsky, 2013).Goal 11 of the United Nations Sustainable Development Goals framework aligns with the recent emphasis on ecologically friendly urbanization in national planning (UN, 2015). Even while the connection involving urbanization, economic development, and energy consumption has been researched exhaustively in the past years, there are surprisingly few studies examining the same in emerging nations.

Currently, this area is analyzing the research it has collected on the following topics:

1) How do we agree on what counts as a big problem?

2) The most important factors influencing the energy needs of cities throughout the globe contexts.

3) Thirdly, do urbanization, energy use, and economic expansion go hand in hand?

4) Four How does urbanization effect the planet's energy consumption? Does the rise of the city result in more effective energy management?

The above chapter will be broken down into sub - headings such as an introduction, an economic study of urbanization and energy consumption, include both a theoretical analysis of how urbanization affects energy use and a series of actual studies on the environmental impacts of cities.

For the sake of clarity, we should establish a few helpful ideas in relation to the primary research questions we want to study. When discussing the outcomes and conclusions, it is crucial to define these terms openly and accurately.

4.2.0 Urbanization

Many books and articles have been written on what exactly urbanization is. As more and more people leave rural regions for urban centers, this trend is known as urbanization (Parikh and Shukla, 1995). Urbanization, as defined by Azam and Khan (2016), is the migration of a larger and larger share of the working population from agrarian to urban areas. More people choose to live in cities and towns since that's where they can find opportunities for both housing and jobs, hence their populations rise. Due to the academics' varied use of the term, "urbanization" may have a variety of connotations. It may be reduced to the increase in population and urbanized land area in cities (Chikaraishi et al., 2015,).

Researchers's uses of the term "urbanization" suggest that it may have a variety of connotations. To put it more precisely: " expansion of both the human population and the amount of land under urban control " (Chikaraishi et al., 2015,).

In contrast, " Changes in the economy, population, government, culture, technology, and social structure, as well as the natural and built environments, all contribute to what is known as urbanization. The degree of urbanization is a measure of the economy's progress and stability (Gasimili et al., 2019). Urbanization and economic growth go hand in hand (Gasimili et al., 2019; Kasman and Duman, 2015), yet it is not always apparent which contributes more to the other. Rising global warming may be traced back to human activity, particularly in metropolitan areas (Afridi et al., 2019). According to Madlener and Sunak (2011), between 1970 and 2010, less developed countries experienced a much higher rate of urban growth than did more advanced nations; and between 2010 and 2050, it is predicted that the urban population in less industrialized economies might treble, with metropolitan areas seeing the fastest average annual growth rate of 3.3%. Because to the rapid urbanization occurring in Africa and Asia, approximately by 2050, 83% of the global population will reside in low-income areas. While they only account for 2% of the Earth's land area, urban centers are responsible for producing 70% of the world's carbon dioxide emissions and using 75% of its resources (Madlener & Sunak, 2011; Pacione, 2009). Furthermore, Most of the energy used in metropolitan areas across the world comes from fossil fuels, and the bulk of that is used for transportation of people.

United Nations estimates predict that by 2050, 67% of the global population would reside in urban areas, a rise of more than 24% between 1950 and 2014. Additionally, by 2050, the urban population of Africa and Asia is projected to reach 56% and 64% of their respective total populations, up from 40% and 48% in 2014. About 90% of the projected increase in urban populations between now and 2050 will happening in Asia and Africa. This will bring the total number of people living in cities worldwide to 2.5 billion. Related research conducted by Afridi et al. (2019) in the SAARC nations found that In these countries, the urban population typically makes up about 34% of the total. Moreover, there was a 130-million increase in the urban population from 2001 to 2011 and another almost 250-million increase is projected for the area by the year 2030. Energy from conventional sources is in more demand because of the expansion.

4.3.0 Energy Consumption

According to the definition provided by Halder, Paul, Joarder, and Sarker (2015), energy is crucial to the continued existence of life on Earth. Technology's universal exchangeable medium of exchange is energy, as Dincer (2000) has pointed out. Consumption of energy, both alone and in conjunction with other production variables like labor and capital, is crucial to economic expansion (Apergis and Payne, 2012).

Energy consumption has a major impact on a country's quality of life, and its consumption is rising rapidly as a result of economic expansion, fast urbanization, and industrial development. In order to keep up with the ever-increasing global need for energy, we rely on two primary types of energy sources: those that are either finite or constantly replenished by nature.

Nonrenewable energy sources include natural gas, oil, and coal, with roughly 75% of primary energy use coming from these three. In spite of the fact that the world has enough oil and gas to last another 50 years, according to Thomas, Greenstone, and Knittel (2016), gas and oil output is expected to reduce by 43-57% by 2030 compared to 1970s levels. Natural catastrophes, the loss of biodiversity, and the cutting down of forests have all been direct results of oil and coal extraction (Kahia et al., 2016). Concerns about the demand, supply, and distribution of nonrenewable energy resources to different consumers have also been central to discussions about regional economic growth and environmental conservation (Liu, Huang, Fuller, Chakma, and Guo, 2000).

Researchers Jebli, Youssef, and Ozturk (2016) discovered a favorable correlation between the use of fossil fuels (oil, coal, and natural gas) and economic development.

As a result of the societal costs associated with generating and using fossil fuels, the high degree of price volatility in the energy market, and the complex geopolitical situation that surrounds fossil fuel production around the world, energy security has become a concern for both energy importing and energy producing countries (Apergis and Payne, 2012; Apergis, Payne, Kahia et al., 2016).

Switching to renewable energy sources is a crucial step toward attaining Steady growth (Dincer, 2000). Having a reliable and renewable energy source is essential, but not sufficient, for a civilization to progress. Concerns about energy security and the environmental effect of human activities have led some to propose solutions including greater and effective energy use and the development of renewable alternatives to nonrenewable energy sources. When considering issues of energy autonomy, environmental sustainability, and environmental deterioration, renewable energy sources are frequently thought to be the best options, Lotz and Dogan, (2018).

In addition, Tahvonen and Salo's (2001) review of the renewable energy industry revealed how numerous sources of renewable energy were available even before industrialisation. In reality, there may be a pattern to the changeover from renewable to nonrenewable energy sources, with economies relying heavily on renewables in the early phases of development. The proportion of renewable energy used drops and the proportion of fossil fuels rises afterwards.

Renewability and environmental friendliness are the hallmarks of renewable energy, which are generated from naturally renewable sources and put to many uses. One other perk of renewable energy is that it may be used to power unserved rural regions that are rich in natural resources without expanding the existing national grid (Lotz and Dogan, 2018). Given that renewable energy accounted for about 13% of global primary energy supply in 2004, it is expected to see the greatest rate of growth of any global energy source (Apergis et al., 2010). Importantly, between 2007 and 2035, worldwide renewable power output will expand by an average of 3% per year, while there will be a yearly average rise of 2.6% in power use. An estimated 54% and 26% of total renewable power output comes from hydroelectricity and wind energy, respectively (Apergis and Payne, 2012).

4.4.0 Economic Development

The development process is influenced by a wide range of elements, including but not limited to economic expansion, urbanization, mobility, modernization, technological progress, and the environment (Parikh and Shukla, 1995). Energy consumption is strongly influenced by economic growth (real GDP), relative energy prices (REP), foreign direct investment (FDI), and measures of financial development (Mudakkar et al., 2013). Rising energy demand is the result of a multitude of causes, including rapid economic growth, rising urbanization, population growth, business expansion, greater industrial production, and increased automobile use (Afridi et al., 2019).

In addition, the goal of sustainable development is to guarantee adequate energy supplies, reduce the negative impacts of energy use to more manageable levels, and assist consumers in meeting their needs with less energy input by promoting more efficient use of energy resources.

The term "energy sources" is often used to describe the many locations from which the economy draws its energy. A significant contributor to economic expansion, industrialization, urbanization, and general economic development is the availability of reliable and affordable energy

However, in addition to human effort and financial investment, energy may be cited as a component of production.

Moreover, energy is crucial in the manufacturing process since it is employed in the end product's creation step by step. Energy is a crucial input in all stages of production and in many stages of consumption as well (Imran and Siddiqui, 2010).

There is a general rise in consumer demand, which drives up energy consumption and, in turn, carbon dioxide emissions, regarded as the most pernicious drivers of environmental deterioration (Ahmad and Majeed, 2019). Every national economy consists of three divisions: agricultural, industrial, and service. According to Sen (2016), structural change is fundamental to economic progress, and not only a contributing component. This shift boosts economic output and income as a whole (Sen, 2016), but it also increases demand for energy.

4.5.0 Industrialization and Infrastructure.

Population shifts from rural to urban regions are referred to as urbanization and it is an important part of the economy's socioeconomic growth. Energy consumption rises to suit customers' varied demands as manufacturing moves from lower - intensity output to high-energy intensity production. New construction, innovative technology, and widespread industrialization all play a role in this revised method of manufacturing (Madlener and Sunak, 2011). The growth of factories directly affects the size of cities. Due to its positive impact, the industrial sector expands as urbanization becomes the primary driving force in determining the economic structure. (Yassin and Aralas, 2019). (Yassin and Aralas, 2019). Conversely, the expanded urban areas will be the sites of the fast expansion of industry and production, two of industrialization's primary components. Industrialization has led to rapid economic expansion in many Asian nations, but there has been a lag between structural changes and economic output (Sen, 2016). Azam and Khan (2016) asserted that urbanization is caused by industry and that the concentration of people in cities hastens the collapse of rural and agricultural areas. Asia's rapid population and urbanization expansion may be attributed in large part to the region's booming economy and rising industrialization.

Energy also plays a crucial role in industry, which in turn fuels economic development and expansion. As a result, the concentration of humanity in cities is a major driver of global energy demand.

According to Chen, Lu, and Zhang (2009), rapid urbanization in Asia may be attributed to the region's alarming prevalence of industrialization and economic development, which have stimulated population expansion.

Rahman (2019) elaborated on this topic, stating that the expansion of Bangladesh's industrial sector contributes to both the country's economic growth through broader-based expansion and the expansion of the country's urban centers. He explained that the rise in energy needs that accompanied industrialization, urbanization, and Bangladesh's subsequent development were all factors he considered important. Not only that, but around 40 percent of the energy used in cities is produced by buildings. As a result, industrialization is a part of urbanization, the success of which depends largely on the accessibility and efficient use of energy.

4.6.0 Household services.

To gauge the extent to which natural resource depletion has altered the economic structure, urbanization is a crucial metric. Most critically, households in metropolitan areas require access to affordable and reliable energy sources for essential home services. New studies show how urbanization pushes individuals out of the countryside and towards metropolitan centers. This increases the number of people living in cities, which in turn raises their energy needs (Bakirtas and Akpolat, 2018).

Increases in energy consumption may also be attributed to rising urban density (Shahbaz et al., 2015). Jones (1991) found that a 10% growth in urban inhabitants resulted in a 7% increase in energy demand, even when per capita income and industrialization remained same. As noted by Parikh and Shukla (1995), a ten percent increase in urban population results in a 4.7% increase in per capita energy consumption.

Greater energy consumption is attributable to urbanization for several reasons, as discussed by Salim and Shafiei (2014). In their opinion, the direct operational expenses of home heating, ac system, and electricity in residential buildings are higher than those of other urban activities. According to Afridi (2019), et al the situation is essentially the same throughout the SAARC nations. Housing demand and energy-intensive lifestyles both rise in tandem with urbanization (Anser et al., 2020). According to Poumanyvong and Kaneko's (2010) "compact city" idea, as urban populations grow, economies of scale will be realized in areas like public education, healthcare, and energy generation, reducing environmental impact (Poumanyvong and Kaneko, 2010). Urban regions have a larger per capita income than rural areas, which is a significant factor since family spending is directly tied to income. In the long run, this high-income level may guarantee more comfortable living conditions (Chikaraishi et al., 2015). As urban populations grow and use more resources to maintain their better levels of life, global warming will continue to worsen.

Researchers Poumanyvong and Kaneko (2010) looked examined data from 99 countries to determine how urbanization affected energy consumption and CO2 emissions across socioeconomic brackets between 1975 and 2005 While urbanization was shown to have a beneficial effect on energy consumption and carbon emissions across all economic brackets, this effect was found to be more prominent in the strong and thriving economies. A similar trend was shown by Imai (1997), who showed that growing urbanization and population both raise energy needs. However, his examination of causes pinpointed urbanization as the root driver of both rising population density and energy demand.

The resources needed to generate food and other biomass energy are a prime example of the indirect energy consumption that cities represent (Salim and Shafiei, 2014). Primary sector operations become increasingly resource and energy demanding as a result of declining agricultural workforces and rising non-agricultural populations (Jones, 1991).

4.7.0 Other Factors

On occasion, informal marketplaces or sectors have an impact on energy consumption. This is particularly true of industries that significantly contribute to urbanization in developing nations (Madlener and Sunak, 2011). Kuralbayeval (2019) looked at how tax changes help these industries reduce unemployment in developing nations. In addition to contributing to urbanization and energy consumption, the economic activity generated by these sectors are essential to the well-being of these nations (Kuralbayeval, 2019). What is known as "the informal sector" refers to the portion of the economy that is not accounted for in official statistics like gross domestic product (Madlener and Sunak, 2011). In addition, the unconventional economy is defined as an industry that generates unrestricted employment and sources its energy needs from the official economy. Because of this, energy tariffs will soon be included into the broader framework of environmental taxes and state taxes for urban expansion.

In addition, urbanization remains at the core of societal development, since it is in the world's main cities that the bulk of banking, communication, and transportation activities take place. (Gasimli et al., 2019). Urbanization has been shown to increase energy consumption, according to research by Azam et al. (2015). In a similar vein, Gasimli et al. (2019) demonstrated the interconnected nature of Sri Lanka's energy use, international commerce, increasing urbanization, and greenhouse gas emissions. However, as urban populations grow, air quality will suffer from factors including rising power usage, more cars on the road, and diminished tree cover brought about by construction (Mulali et al., 2015). In conclusion, rising CO2 emissions may be traced back to the urbanization process's connection to both economic growth and energy use (Abbasi et al., 2020). In contrast, as a result of high urbanization densities, the environment would benefit from increased societal awareness and economies of scale for the construction of urban infrastructure

4.8.0 A Connection Between Economic Growth, Population Growth, Urban growth, and Energy Use

Density of urban areas is a function of urban infrastructure and energy consumption, both of which are indicators of economic growth (Madlener and Sunak, 2011). Rising urbanization and energy use are two byproducts of a thriving economy, which in turn spurs increased production of goods and services to meet rising demand (Bakirtas and Akpolat, 2018). Economies that rely on production, transportation, and many other energy-intensive sectors are more likely to expand into metropolitan areas. Urbanization, economic structure, population density, and economic development were all factors that Parikh and Shukla (1995) considered while assessing the impact of these factors on energy consumption including developed and emerging countries.

Using China as an example, Shahbaz et al. (2012) analyzed the correlation between energy use and GDP growth over a wide range of variables from 1971 to 2011. The research found that increasing energy use was directly correlated with higher economic growth. A reciprocal causal relationship exists between economic growth and international trade, between energy consumption and capital, financial development and expansion, and the two (Shahbaz et al., 2012). Foreign direct investment (FDI) flows, economic expansion, trade liberalization, and a high human development index are all positively and substantially associated with higher energy consumption, as was shown in a related study by Azam et al (2015).

Sadorsky (2013) found that industrialized countries are more likely to have a greater consumption level than poor nations; nevertheless, affluence, urbanization, industrialization, etc. all impact energy intensity. Energy consumption rises with urbanization due to higher levels of consumption and production, while energy efficiency rises with urbanization because to economies of scale. This makes gauging urbanization's impact on energy intensity challenging (Sadorsky, 2013). Moreover, the industrialization is associated with economies of scale and rising consumption and output.

Increases in industrial activity led to higher energy consumption since better improved output have higher energy intake than ordinary agriculture or basic industry (Sadorsky, 2013, Luo et al., 2020). In this way, industrialization may help bring about urbanization, increase the number of people who live in cities, and enhance their capabilities (Luo et al., 2020). Urbanization and industrialization go together. Like industrialization, urbanization contributes to and is tied to regional economic growth (Storper and Scott, 2009). Even while the connection connecting urbanization and industrialization is endogenous and more well-organized in industrialized countries, it is exogenous in economies with excessive or lagging modernization (Luo et al., 2020). According to research conducted by Vollrath et al (2016), the rate of urbanization in emerging countries has not been directly proportional to the rate of industrialization in recent decades. If we compare the proportion of the population that lives in cities in China and Nigeria, we find that the latter has urbanized at the same rate as the former, but that China's industrial development has outpaced that of Nigeria (Vollrath et al., 2016). Therefore, the key to urbanization's long-term sustainability lies in the reciprocal nature of its interaction with industrialization (Luo et al., 2020).

Increasing urbanization and energy use, reflected in higher atmospheric carbon dioxide levels, have been linked to rapid economic growth. The statistical research demonstrated an increase of GDP is the most influential factor in setting the level of CO2 emissions. If we generalize this result, we discover that for every 1% increase in energy use, CO2 emissions per person rise by 0.52%. Turkey's CO2 emissions have been steadily rising due to the country's ongoing structural economic change brought on by industrialization and urbanization. They also noted that 20 nations were responsible for 82% of all energy-related CO2 emissions, while the United States, China, and India accounted for 51% of all emissions. The demand for energy in developing nations has skyrocketed in recent years due to their rapid economic and demographic expansion (Ahmad and Majeed, 2019). Greater energy consumption in South Asian nations, for instance, is a direct result of the region's rapid economic development in recent decades. Among all regions, South Asia had the greatest economic growth of 6.9% in 2018, and the area as a whole is projected to have an average growth rate of 6.9% in 2019 and 2020 (WDI, 2018).

And moreover, urbanization is increasing at a faster rate in emerging nations than in industrialized ones (Behera and Dash, 2017). The rapid urbanization of emerging nations is likely to have far-reaching consequences for the region's energy needs. Colombia, India, Indonesia, Kenya, Malaysia, and Mexico are just some of the new emerging nations that Bakirtas and Akpolat (2018) have studied to learn more about the connection between energy consumption, urbanization, and economic development. Because of their excellent governance and sustainable development, in addition to the fact that they will likely provide retail businesses and promising opportunities for growth, these six nations are said to be able to replace BRICS (Bakirtas and Akpolat, 2018). The effect is a quickening of the pace at which energy consumption is increasing. Thus, the increasing necessity power generation in india, China, and other rising countries is a significant cause for concern due to the world's diminishing availability of energy sources, especially nonrenewable ones. (Ewing and Rong, 2008). Consequently, growing urbanization in countries like China contributes to rising national energy consumption, since urban households utilize 55% higher energy per person than rural ones (Shahbaz et al., 2015). With its higher utilization fossil fuel , the United States has surpassed China as the world's largest consumer of energy (Rao et al., 2012). Recent years have seen a proliferation of studies focusing on the connections between Chinese urbanization and energy consumption from seemingly every angle.

CHAPTER V

5.1.0 The Effect of FDI on Economic Development in Central and Eastern European Countries.

Using data from 2000-2012, Hlavacek Petr and Bal-Domaská Beata (2016) analyze the impact of foreign direct investment on the economies of a number of CEE states. The Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, and Slovenia are all part of this group. In the first part, we examined the dynamics of foreign investment and GDP using a model inspired by the Endogenous Growth Model. There seemed to be considerable regional variation in the rate of FDI and GDP expansion, as shown by the data. Foreign direct investment (FDI) in terms of GDP production is highest in Estonia, preceded by Hungary, the Czech Republic, and Slovakia. Investments from outside have less of an impact on the economies of Lithuania, Poland, Latvia, and Slovenia (Hlavacek Petr, Bal-Domańska Beata 2016). Growth in gross domestic product (GDP), foreign direct investment (FDI), and investment all showed statistically significant relationships in their research. Increases in GDP are one of the most tangible benefits of a thriving foreign direct investment sector. After a relatively quiet period from 2009 to 2012, FDI began to have a more noticeable impact on economic development in Central and Eastern European nations (Hlavacek Petr, Bal-Domańska Beata 2016).

5.2.0 Financial Growth and FDI Into Eastern European Nations.

The privatization process, during which these nations privatized a considerable number of large firms of vital importance to their national economies, made them attractive for foreign direct investments. The velocity of these privatization procedures, the restructuring of economies, and the development of operational security markets that enabled portfolio investments all played important roles in the geographic segregation of FDI. The economy enters a conjunctural stage of the business cycle following the year 2000, characterized by a period of rapid expansion. There was a rise in foreign direct investment during this period, and the accession of Central and Eastern European countries to the European Union in 2004 boosted the EAA's progress of administrative and, most significantly, financial interdependence.

Prior to the global financial crisis of 2008, all of these countries' GDP grew faster than the EU average when they joined the EU. Only Poland, with its more constrained economy, maintained long-term development despite the global economic crisis that began that year (2009). In Lithuania, Latvia, and Estonia, the GDP drop came close to the maximum of 15%, making it one of the countries most affected by the economic crisis. As a matter of fact, economies of the Baltic states swiftly recovered from the impacts of the crisis and have been growing at above-average rates. Slovakia and Poland did not have economic development as rapid as the Baltic nations, but their economies did expand at a far quicker pace than the rest of the EU states. In the third group include countries like the Czech Republic, Hungary, and Slovenia, all of which saw slower-than-average economic development during the crisis that hit the European Union in 2008. According to Prochniak (2011), this is because developing nations often experience higher rates of growth. This hypothesis is supported by the fact that Slovenia and the Czech Republic possesses the strongest GDP per capita rates in all of Central and Eastern Europe.

Growth in both FDI and GDP occurred between 2000 and 2012 in the nations under study. displays the total amount of FDI and GDP per person. Slovakia, Lithuania, and Estonia reported the highest growth in FDI, with mean scores increasing by 23%. Stocks of FDI expanded by around 17-18% annually on average in the Czech Republic, Latvia, and Poland. In contrast, growth in Slovenia was more erratic (15% annually), while in Hungary it was even lower (14%). Differences in growth rates can also be attributed to the total amount of investment made in the years leading up to the year 2000; in those years, countries whose economic liberalization mechanisms had been finalized and which were already attractive to foreign investors attracted a greater amount of foreign investment per capita than countries whose privatization processes were still in the works.Major discrepancies across nations emerge when looking at their respective per capita GDP and foreign direct investment levels.

Foreign direct investments were mostly focused on Estonia (almost 87%) and Hungary (83%), measured by their respective GDP per capita. A margin of not more than 70% was seen in the Czech Republic and Slovakia. Lithuania (38%) and Slovenia (34%), both with lower-than-average values, recorded the lowest proportions of FDI.

There is a large disparity across nations in how their FDI has grown spatially in relation to their workforce up to 2012. Disparities in foreign direct investment (FDI) per worker by country, from 2012 to present. The levels of investment make it possible to classify the nations into three broad buckets. Estonia, Hungary, and the Czech Republic were reported to have the greatest levels of FDI relative to their total labor forces. Because of their well-established trade relationships with their neighbors, the Baltic states and the Czech Republic both saw a surge in foreign investment. The second category contains Slovakia and Slovenia. Unlike Slovenia, whose economy has slowed to a crawl, Slovakia's has been growing at a healthy clip in recent years, especially before the economic crisis. This has been largely due to a shift in the country's priorities toward exports, which has been fueled in part by an increase in direct foreign investments. When adjusted for population, the Slovak automobile sector is among the continent's most prolific exporters of passenger vehicles. The third set consists of Poland, Latvia, and Lithuania, which have the greatest economy of the nations tracked but are the least accessible to global investment.

Since joining the EU in 2004, the nation has seen a rise in FDI thanks to the unrestricted flow of products and services to the EU Single Market, gained greater socioeconomic stabilization, and a more favorable business environment. UNCTAD statistics for both before and after 2004 shows that FDI inflows were greater after the entrance than before 2004 in all countries studied. In terms of disparities across nations, Hungary and Slovenia had the lowest inflows of direct foreign investment, although both were still greater than they had been before their countries joined the EU. Lithuania, Latvia, Poland, and Slovakia saw the highest inflows. Growth in the export sector, in particular, was aided by the increased influx of direct foreign investment.

Profits made by outside investors were also reinvested in the home economy, a trend that signaled rising optimism in the future of the economies of the new member states. Many Central and Eastern European (CEE) nations have lower labor expenses than their Western European counterparts (Gauselmann, Knell & Stephan, 2011). The economic collapse and competitive pressure from neighboring Balkan countries and Turkey have dimmed the excitement of foreign investors in recent years.

5.3.0 Impact of Fdi on Economic Growth In Germany

German firms get access to international markets through FDI. At the same time, Germany attracts investment from firms throughout the world. Both help the German economy expand and remain stable, which in turn safeguards jobs. This highlights the need of ensuring that foreign investments are fully protected under the law. Germany gains a great deal from globalization. Since 1990, German FDI has expanded by a factor of almost six, reaching a current level of around 1.2 trillion Euros. German firms are able to secure employment and stay viable at home thanks to their efficient execution overseas, which takes use of local comparative advantages. German corporations create yearly overseas sales (2017: EUR 3.1 trillion) through their investments in over 38,000 companies, that's almost two times the amount as German exports (2017: EUR 1.3 trillion) (Deutsche Bundesbank, 2017). Foreign direct investment is crucial to keeping Germany's market dynamic and competitive. Foreign direct investment (FDI) also aids in the implementation of progressive policies in the areas of labor and social welfare in underdeveloped nations.

Foreign investment is becoming more important to Germany's industrial development. Foreign corporations manage industrial facilities via their investments and build commercial partnerships with German partners. In Germany, employment is both guaranteed and created by such investments. Foreign direct investment (FDI) is crucial to Germany's economy, as shown by data from the Deutsche Bundesbank. Nearly 3.1 million employments in Germany are directly attributable to the presence of foreign investors in some 17,000 businesses. In 2017, they earned 1.6 trillion euro in sales in Germany.

On the other hand, industrialized nations are seeing a steady decline in FDI. conversely, large emerging markets are more attractive since they are poised to drive global economic development. In 1990, developing and rising nations received around 17% of all foreign direct investment. It reached 54% at the end of the year 2018. Europe is becoming an increasingly less desirable place to set a business. The European Union (EU) owned 47% of the world's FDI stocks in 1990, but that figure has decreased to 21% by 2018. Therefore, Europe has to take strong action to ensure it continues to be an attractive location for international investment.

5.4.0 Reneging on Thorough Pre-Investment Analysis in Germany

Sadly, a growing number of nations are taking measures to limit FDI from outside. About fifty-five nations changed their regulations on international investments in 2018. This is the largest percentage of new limits introduced by these policies in at least two decades. To ensure the safety of investments, national security screening was crucial. Eleven nations have enacted similar regulations since 2011, with a further 41 countries having strengthened existing tools.

It's not only the United States that this is happening; Germany is seeing the same thing. The political dispute over whether the government has adequate power to control undesirable investment was stoked by the rise in Chinese investment. Proponents of stricter investment screening argue that purposeful and, at times, state financed investments in innovative technological businesses pose a threat to the innovative capacity and long-term viability of the economies of Germany and Europe. More stringent regulations are advocated by some as a means to encourage overseas market liberalization ("reciprocity"

The German government has increased scrutiny of international investments in both 2017 and 2018. The German Foreign Trade and Payments Act (Aubenwirtschaftsgesetz) is scheduled for a further complete overhaul in 2020, raising the prospect of even stricter regulations. Regulations standardizing the EU's approach to assessing potential investments were enacted at the start of 2019. The German business community supports preventive actions that protect citizens and the country. It is also important to prevent foreign state-subsidized investment from distorting markets or weakening the social market system. However, it is important to make sure that investment screening is not used as a tool of industrial strategy and that foreign investment is accepted in Germany.

5.5.0 Supporting Free Trade and Open Markets via Investment Agreements

Political risks must be mitigated in order to encourage German investment overseas. As a result, the next generation of Bilateral Investment Treaties has to have robust safeguards (BIT). Contracts of this kind must also protect the authority of governments to impose necessary regulations in the public interest.

As of the Lisbon Treaty's implementation in December 2009, equity security fell within the scope of the European Union's common commercial policy. Accordingly, it has been discussed during EU FTA talks (FTAs). The European Court of Justice ruled on the EU-Singapore FTA in 2017 and said that the Union and its members had jurisdiction over some areas of bilateral investment treaties. The Canadian Economic and Trade Agreement (CETA) includes cutting-edge protections for investors. Conflicting interests are represented in the Comprehensive Economic and Trade Agreement (CETA). The Union's exclusive competence chapters are now being implemented provisionally while ratification is still taking place in the member states. However, the investment protection provision is not yet in effect since it must be ratified by the members. The European Union and Singapore have worked to establish not one but two different treaties: a free trade agreement and an investment protection pact. The trade deal will go into force before the end of 2019 after being approved by the European Parliament and all EU member states. In order for the Investment Protection Agreement to become binding, all signatory governments must ratify it in line with their respective legal frameworks. Between the middle of 2019 and early 2020, Vietnam as well as the European Union signed a free trade agreement and an investment protection legislation. Neither the European Union nor its individual member states have approved the Free Trade Agreement or the Investment Protection Agreement.

The EU and China are now in the midst of BIT negotiations (Comprehensive Agreement on Investment, CAI). These discussions, which were first initiated in 2013, have dragged on for far too long. The discussions include topics such as market access and protection for investments. The parties finally began exchanging market access bids in the middle of 2018.

CHAPTER VI

6.1.0 Methodology Review

In Chapter 3, we address several hypotheses and frameworks derived from the available literature, as well as factors that seem to be associated to CO2 emissions. In my thesis, I will use econometric analysis to look into these hypotheses and variables. As a result, this section gives a synopsis of the relevant literature as well as an explanation of the methods used by the authors. Tabular data 1 provides a summary. The variables and study questions are introduced in this section. Secondly, the processes and tests involved in using the appropriate econometric models will be detailed. Furthermore, the data sources that were utilized will be briefly explained. The latter sections of this chapter provide the thesis's guiding model and its implications, respectively.

There are approximately two categories of research inquiries: unidirectional and bidirectional. The first examines the effects of various factors on CO2 emissions, whereas the latter analyzes (the directionality of) the relationships between these factors. This difference is less definitive in reality, nevertheless, since studies that use CO2 emissions as endogenous variables also often ask questions about the arrow of causality. The first table, for instance, Chandran and Tang (2013) examine the (direction of) interactions between all the variables in addition to answering a unidirectional research question. And even in publications that ask a multidirectional research question, CO2 emissions are often treated as the primary (dependent) variable. Therefore, take into consideration that the procedure doesn't quite necessarily depend on whether the study topic is uni or bidirectional.

6.2.0 Descriptive Statistics

Descriptive statistics play a crucial role in offering a quantitative overview of the data utilized in a study and explaining its key statistical qualities or attributes. In descriptive statistics, data is often broken down into means and standard deviations. Metrics of central tendency include the mean and median, whereas variability may be measured using the standard deviation, Kurtosis, skewness, Jarque Bera, and the minimum and maximum.

When numbers are sorted in either descending or ascending order, the middle number is the median, whereas the mean is the average value.

6.3.0 Unit Root

A unit root test is the initial stage in every econometric estimation. Assuming a unit root in the data (i.e., is not stationary), then X (here) has the same value as it had before, but with some random variation added in (Dougherty, 2016):

$$x_t = x_{t-1} + \varepsilon_t$$

This may hamper our ability to draw firm conclusions. It is possible to stabilize the data by differentiation, and then the data can be integrated with order one I (1)) to address the issue of stationarity. If the data is still not stationary, we may extract differences once more, resulting in an integration of order two (I (2) (Dougherty, 2016).

Types of tests for unit roots employed in the scholarly literature consulted for this chapter are discussed below. The most basic unit root test will be covered first, nevertheless, so readers may better understand the whole unit root testing process. The Dickey-Fuller t test is being used here.

Use this sample setup to see how the test is supposed to operate in practice.

$$y_t = \beta_1 + \beta_2 y_{t-1} + \varepsilon_t$$

$H_O: \beta_2 = 1 \quad H_A: \beta_2 < 1$

If β_2 = 1, If this is the case, the variables are said to non-stationary (i.e., has a unit root), but if it is less than 1, then the data is stationary, which is the alternative hypothesis.

The following formula for the t-test statistic determines whether or not the null hypothesis will be rejected:

$$t = \frac{\beta_2 - 1}{s.e.(\beta_2)}$$

There has to be a comparison between this and the threshold values.

After defining what a unit root test is, we'll go on to discussing the various tests used in the scholarly literature. Time-series data articles are differentiated from panel data articles. Unit root tests are first applied to time series data. Due to their limited data, Chandran and Tang (2013) propose using the Dickey-Fuller Generalized Least Squares (DF-GLS) method (time-series data for 1971-2008). Because of the limited size of their sample, Tang and Tan (2015) also revise their critical values. They start by using the ADF and KPSS tests. However, the so-called "size distortion issue" renders these tests unreliable for tiny samples. Having a limited sample size isn't the only thing that may reduce the accuracy of a unit root test. The likelihood of rejecting the null hypothesis will increase if structural breakdowns occur in the series (H0: unit root).

As a result, Boutabba (2014) use the Lagrange Multiplier (LM) test statistic, both with and without breaks. This test is very credible due to its ability to differentiate between the alternative and null hypotheses (Boutabba, 2014).

Currently, we'll be looking at studies that discuss the use of unit root tests on panel data. First, there are two distinct kinds of unit root testing, as defined by Pao and Tsai (2011). The LLC and Breitung tests fall into the first group since they check for a shared unit root across several cross-sections. The other group examines whether or not a given cross-section has a unique unit root (using methods like the independent-samples t-test, the analysis of variance-covariance matrix).

Panel unit root tests are susceptible to bias due to cross-sectional dependency. When data from different nations are dependent on one another in a way called cross-sectional dependency, it indicates that these data are correlated in real (Verbeek 2017). Using the Friedman, Frees, and Pesaran test, Rafiq (2016) investigates the possibility of cross-sectional dependency.

6.4.0 Lag Length

First, the lag duration of the variables should be selected before any cointegration tests are performed.

The AIC, SBC, FPE, HQ, and LR tests are just a few of the available options commonly used in econometric analysis (Tang and Tan 2015). Among them, the Akaike Information Criterion and the Schwarz Bayesian Criterion (SBC) are the most often used.

6.5.0 Cointegration Test

Spurious regressions may arise when the underlying variables are not stationary. It's as though two variables are connected when in fact they aren't (Dougherty 2016).

Unfortunately, this causes problems with the reliability of estimators and test statistics. Conversely, if these nonstationary variables have what is known as a cointegration relationship, which is stable over the long term, this will not be the case. Therefore, variables are said to be cointegrated if they are each I (1) yet the linear combination of these variables is I (0) (Maddala et al. 1998). The next process, therefore, is to check for cointegration once unit roots and the best lag duration have been identified.

For a more mathematical explanation of cointegration, see Verbeek (2017). Assume x_t and y_t are I (1). There is cointegration if and only if the relation between $y_t - \beta x_t$ (for certain β) equals I (0). They are all following the same pattern. This implies that x_t and y_t maintain a reasonable degree of closeness throughout time. A false regression would occur if these variables gradually began to diverge over time. Cointegration, in its simplest form, refers to the presence of a long-run link between nonstationary data. Several types of cointegration tests will be explored below. The tests used for time series data come first, followed by the panel data tests that are more prevalent.

As a first step, we will review various published works that have used cointegration tests on time series data. Tang and Tan (2015) stress the need of using a multivariate cointegration strategy rather than a single-equation approach (Tang and Tan 2015). Among the most popular cointegration tests is the Johansen test. When doing the Johansen cointegration test, Chandran and Tang (2013) highlight three crucial procedures. The first step is picking the right lag time. Finally, it is possible that the null hypothesis is being over-rejected due to the tiny sample size (H0: no cointegration). The LR statistic may be tweaked to address this problem (Chandran and Tang, 2013).

Since it is believed that all variables are endogenous, the Johansen cointegration test benefits from being insensitive for the choice of the dependent variable (Tang and Tan 2015). Last but not least, if all variables are endogenous and the test can uncover several cointegration relationships, then it will pass.

The cointegration test used by Boutabba (2014) is the de ARDL F-bounds testing approach, which was created by Pesaran et al. (2001) and is limited to time series. This testing method offers a few benefits over the cointegration procedures of Engle and Granger and Johansen and Juselius. It is possible for the variables to be integrated with order one and/or in levels. Another benefit of this approach is that it outperforms the Johansen and Juselius technique for detecting cointegration when working with a limited sample size. Furthermore, the limits test provides objective long-run estimates even if some of the independent variables are endogenous (Boutabba 2014). However, if the variables are integrated with order 2, the F-statistic will not be valid. The F-test does not follow a normal distribution and hence relies on the order of integration of the variables, the number of explanatory variables in the ARDL model, and the presence or absence of an intercept and/or a temporal trend (Boutabba 2014).

6.6.0 Causality Test

If there is a long-term causal link, then the cointegration test may reveal that fact. The Granger causality test (based on VECM) can tell us which way this connection points. Granger causality is described as follows by Riti et al. (2017): "A variable say 'x' If the present values of y can be jointly described by the historical values of x and y, then y is said to have a Granger cause. When a long-run cointegration connection is found by a panel or time series cointegration test, it implies that Granger causality exists in at least one direction (Pao and Tsai 2011).

With the exception of Riti et al. (2017), none of the other studies that use a VECM model include any details about the estimation process for the model's long- and short-term parameters.

6.7.0 Ardl and Nardl

Two variables are used to explain the data in the autoregressive distributed lag model (i.e. variables on the right-hand side of the model). The model incorporates not only the lagged values of the dependent variable but also the lagged values of the independent variables (Dougherty 2016).

Utilizing an ARDL model allows for rich variations to be included while minimizing the issue of multicollinearity (Dougherty 2016). A causal connection that persists throughout time is said to be dynamic (Verbeek, 2017). Also, the model accommodates time-series variation in explanatory factors (ARUP 2010). This model may simultaneously estimate both long-term and short-term associations (Boutabba 2014). The

ARDL model also allows for consistent estimators to be derived regardless of whether the variables are I (0), I (1), or a mix of the two. But if (some of) the variables, are I (2), the estimates will be off (Baek 2016; Rafindadi et al. 2018).

Asymmetry with regard to positive and negative changes in the regressor are accommodated in the NARDL model, which is a single-equation error correction model. To address the flaws of the Symmetric or Linear Auto regressive Distributed Lags, Shin et al. (2014) developed the NARDL technique, which assumes that changes in the explanatory variable have the same effect on the explained variable whether the change is positive or negative. For example, a significant increase in the explanatory variable would result in a proportionate decrease in the explained variable, visa-vi. However, the non-linear auto-regressive distributed lags model captures both the short-run and long-run non-linearities by negative and positive partial sums decompositions of the regressors. That is to say, the impact on the dependent variables might vary depending on whether the alteration in the regressor is positive or negative.

6.8.0 Diagnostic Test

Both the VECM and ARDL models are used in several papers, which then use diagnostic procedures following short- and long-term implementations.

projected costs over a lengthy period of time. The residuals' normality is tested to make sure they follow a standard distribution.

auto-regressive conditional heteroskedasticity (Tang and Tan, 2015) prejudice in the specification (Riti et al. 2017). The ARCH and Ramsey reset tests are used to examine the latter two. Breunsch-Godfrey Lagrangian test (Riti et al., 2017) checks for the absence of autocorrelation. In order to determine whether or not there are structural breaks, Boutabba (2014) uses the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMSQ) to test the stability of the coefficients (Boutabba 2014).

6.9.0 Definition and Measurement of Variables

The following variables stood in for others in this study: carbon dioxide emissions in metric tons per person, energy consumption in kilograms of oil equivalent, and real GDP per person as economic growth. Foreign direct investment (FDI) inflows and stock at current exchange rates and prices (in US dollars) are recorded annually, while urbanization is quantified by the percentage of the population living in cities.

The ratio of real GDP to the population yields real GDP per capita, the most common and widely-used measure of economic growth.

The combustion of fossil fuels and the creation of cement are two major sources of carbon dioxide emissions. Carbon dioxide is one of them, along with other byproducts of burning fossil fuels in the form of gas flaring and combustion of liquid fuels.

According to the global development statistics, energy usage is equal to domestic production plus imports and stock changes, minus exports and fuels provided to ships and planes engaged in international transport.

As a metric of FDI, the net FDI inflow was utilized. Equity capital, reinvestment of profits, other long-term capital, and short-term capital are all accounted for, with the latter two categories assessed in terms of current US dollars.

In most cases, the pace of urban population increase is higher than the rate of rural population growth because people are moving from rural to urban areas in search of better economic and social conditions. As a result, pollution is caused by the strain that urban inhabitants place on their environments.

As a result, we anticipate that urbanization will have a beneficial effect on CO2 emissions.

6.1.1 Data Source

Many researchers use the World Bank Development Indicators for their statistics. Although the EIA and UNCTAD (United Nations Conference on Trade and Development) are used in certain papers, other sources of information are also used (Baek 2016).

Furthermore, all of the variables in this research come from secondary sources. The Bank of Sierra Leone, the Ministry of Finance and Economic Planning, the Environment Protection and Climate Change Secretariat of Sierra Leone, and the World Bank Data Bank (WDI) all contributed data to this research.

6.1.2 Augmented Dickey Fuller Test.

Dickey and Fuller (1979) developed a computer program that can tell whether or not a variable is subject to an a priori random walk and whether or not the variable has a unit root in order to verify their hypothesis.

For the purpose of demonstrating the usefulness and relevance of the expanded Dickey-Fuller test, Hamilton (1994) presents four examples. The null hypothesis presupposes that the dependent variable has a unique unit root at each and every location throughout the distribution. Whatever the specifics of the situation, this holds true.

The main distinctions between the two approaches lie in whether or not the null hypothesis include a drift term, and whether or not the regression used to construct the test statistic incorporates a constant term and a temporal trend. If a drift term is to be included in the null hypothesis, both of these factors must be taken into account. Essentially, it's the same procedure as the Dickey-Fuller test, except it's applied to the model instead of the other way around.

6.1.3 ADF-GLS Test

Traditionally, time series modelers have relied on modified versions of the Dickey-Fuller and Phillips-Peron tests to determine whether a given series has a unit root. However, modern tests have statistical features that are vast improvements over their forerunners. In their 1996 econometric research, Elliott, Rothenberg, and Stock (ERS) modified the Dickey-Fuller test statistic with a generalized least squares (GLS) justification, creating an effective test. This ultimately resulted in the development of a reliable diagnostic tool. This led to the creation of a reliable diagnostic tool. By displaying the modifications made to the traditional Dickey-Fuller test, they demonstrate that their version is more powerful and appropriate for use with small samples. These academics updated them on the most recent developments in their study methods. In instance, a 1996 study by Elliott et al. demonstrates that their "DF-GLS" test "has greatly higher power when an unknown mean or trend is present." With GLS trending, the test series is regressed on a constant and linear trend, and the residual series is employed in a conventional Dickey-Fuller regression.

Trending GLS and degrading GLS are the two main categories of DF-GLS. With or without a trend term, these two procedures are analogous to the standard Dickey-Fuller test. Regression using GLS demeaning only one step, during which a constant occurs; the residual series is then utilized as the regress and in a Dickey Fuller regression. The GLS trending option is selected by default in the DF-GLS test (Baum, 2000) implementation in Strata, whereas the GLS demeaning option is used when the no trend option is selected.

Data stationary was examined in both the constant and constant with trend situations using the Dickey-Fuller generalized linear model. The results of these analyses corroborated those of the unit-root test used in this study.

6.1.4 Philip Perron (PP) Test

Developed by statisticians Peter C. B. Phillips and Pierre Perron, the Phillips-Perron test is a kind of unit root test.   In other words, it is used in time series analysis to check whether or not the assumed integration order of the time series is 1. It expands upon the null hypothesis testing method developed by Dickey and Fuller. The Phillips-Perron test is an extension of the Dickey-Fuller t-test that accounts for the possibility that the underlying process that generates the data has a higher degree of autocorrelation than is acknowledged in the test equation. To deal with this problem, the enhanced Dickey-Fuller test includes delays as regressors in the test equation, while the Phillips-Perron test applies a non-parametric adjustment to the t-test statistic. As long as the autocorrelation and heteroscedasticity of the test's disturbance process are not defined, the test will still hold.

According to Davidson and MacKinnon (2004), the Phillips-Perron test does not operate as well as the augmented Dickey-Fuller test in finite samples.

When analyzing data from a time series, stationarity is very necessary. When the mean and variance of a time series remain constant during the course of the study, we say that the series is stationary. Numerous scientific estimating procedures, including as ADF and PP, are used on a regular basis in order to carry out an analysis on the stationarity qualities of the data exploration. As a consequence of this, the ADF test and the PP test are frequently used in the majority of scientific studies to verify for stationarity.

6.1.5 Statistical Properties of The Model

The simplest case of unit root testing conducted on Autoregressive process is

$$Y_t = kY_{t-1} + \varepsilon_t \qquad (1)$$

Where Y_t represent time series, Y_{t-1}, for the value of Y_{t-1} delayed (time), k represent the coefficient and ε_t symbolized the stochastic term. Stationarity is present in the series if $k < 1$ i.e., no unit root present. It is however non-stationary if $k = 1$ (unit root). The aforementioned unit root validation is commonly referred to as the Augmented Dickey Fuller (ADF) test, that may also express by deducing Y_{t-1} from both the left and right hand said of the autoregressive equation.

$$\Delta Y_t = (k-1)Y_t + \varepsilon_t \qquad (2)$$

Let $\delta = k - 1$ then equation 2 can be written as

$$\Delta Y_t = \delta \cdot Y_{t-1} + \varepsilon_t \qquad (3)$$

Where $\delta < 0$ and $\delta > 0$ are the criteria for stationarity and non-stationarity. The ADF test, however, will just be applicable to autoregressive processes. The ADF test, which allow for P-lagged values of Y_t as well as the inclusion of a constant and a linearization trend, should be employ if AR procedure is required as stated as follows

$$\Delta Y_t = \alpha + \beta \cdot t + \delta \cdot Y_{t-1} + \sum_{j=1}^{p} (\emptyset_j \, \Delta Y_{t-j}) + \varepsilon_t \qquad (4)$$

In the equation shown above, the symbols for the stability value, the linear time trend coefficient, and the autoregressive sequence of lags are respectively denoted as α and **β** respectively. When both α and **β** equal zero (0), the series is a random process that does not include any drift. When only **β** equals zero, however, the series is a random process. In light of this, the alternative hypothesis for the ADF test asserts that Y_t is not stationary and hence has a unit root. According to the counterargument, the series does not have a unit root, nor is it stationary, and Y_t does not have any (alternative hypothesis). In order to determine whether or not the data are stationary, the ADF test statistics are analyzed using a significant threshold that is associated with the threshold. The decision rule states that the null hypothesis cannot be rejected if the absolute value of the test statistics is lower than the critical value.

6.1.6 Cointegration test

Cointegration is the name given to the link between two variables that exists when either stationary linear combination or the existence of a long-term nexus between those variables is present. When determining whether or not the variables have a long-term connection, conventional methods such as the Engle-Granger or Johansen test are often used.

However, the Maximum-Likelihood Johansen method and the Engle-Granger approach have the potential to provide erroneous results when it comes to the depiction of the long-run connection between variables integrated either at the level or the first difference. Pesaran and Shin (Shin et al 2014) proposed the Autoregressive Distributed Lag (ARDL) method as a solution to the previously mentioned issue of spurious cointegration results. This method produces accurate and trustworthy estimate results regardless of whether the variables I (0) or I (1) are integrated first. The ARDL model consists of two components for analyzing time series data. These parts are the AR (auto regressive) lagged values of the explanatory variable and the DL (distributed Lag) of the exogeneous variables. Having lag might have an effect on the value of the regressors at the present time.

6.1.7 The ARDL Model

The basic form of the ARDL model is written below

$$Y_t = \alpha_0 + \beta_1 + \alpha_1 \cdot Y_{t-1} + \beta_0 \cdot X_t + \beta_1 \cdot X_{t-1} + \varepsilon_t \qquad (5)$$

An Autoregressive distributed lag framework demonstrates that the lag order for both explanatory and explained variables is 1.

Given such a scenario, the coefficients of X regression cointegration equation is written as follows

$$K = \frac{\beta_0 + \beta_1}{1 - \alpha_1}$$

The error correction model of the Autoregressive Distributed lag can be written as

$$\Delta Y_t = \alpha_0 + (\alpha_0 - 1) \cdot (Y_{t-1} - k \cdot X_{t-1}) + \beta_0 \cdot \Delta X_{t-1} + \varepsilon_t \qquad (6)$$

The convention form of the ARDL model that comprises of one regression (Y) and Multiple regressors $X_1, X_2, X_3, , , , , , X_n$ can be written as ARDL $(P_0, P_1, P_2, P_3, , , , , , P_n)$ as

P_0 represent the order of lag Y and $P_1 - P_n$ represent the lags of $X_1 - X_n$ respectively. Hence equation 6 can be written as

$$Y_t = \alpha + \sum_{i=1}^{P0}(\beta_{0,i} \cdot Y_{t-i}) + \sum_{j=0}^{P1}(\beta_{1,j} \cdot X_{1,t-j}) + \sum_{k=0}^{P2}(\beta_{2,k} \cdot X_{2,t-k}) + \sum_{l=0}^{P3}(\beta_{3,l} \cdot X_{3,t-1}) + \cdots + \sum_{m=0}^{Pn}(\beta_{n,m} \cdot X_{n,t-m}) + \varepsilon_t \qquad (7)$$

The primary stage in employing the ARDL model is by employing the ARDL bound testing approach to test if the variables are cointegrated. The unrestricted error correction model equation of the ARDL is illustrated below.

$$\Delta Y_t = \alpha + \sum_{i=1}^{P0}(\beta_{o,i} \cdot \Delta Y_{t-i}) + \sum_{j=0}^{P1}(\beta_{1,j} \cdot \Delta X_{1,t-j}) + \sum_{k=o}^{P2}(\beta_{2,k} \cdot \Delta X_{2,t-k}) + \sum_{l=0}^{P3}(\beta_{3,l} \cdot \Delta X_{3,t-l}) + \cdots + \sum_{m=0}^{Pn}(\beta_{n,m} \cdot \Delta X_{n,t-m}) + \lambda_0 \cdot Y_{t-1} + \lambda_1 \cdot X_{1,t-1} + \lambda_2 \cdot X_{2,t-i} + \lambda_3 \cdot X_{3,t-1} + \cdots + \lambda_n \cdot X_{n,t-1} + \varepsilon_t \qquad (8)$$

To verify the existence of cointegration, the hypothesis is tested:

The null hypothesis $H_0\colon \lambda_0 = \lambda_1 = \lambda_2 = \lambda_3 \ldots = \lambda_n$ which represent no long run relationship against the alternative hypothesis $H_1\colon \lambda_o \neq \lambda_1 \neq \lambda_2 \neq \lambda_3 \ldots \neq \lambda_n$ (presence of long run relationship. The decision rule state that if the F-statistics is greater than the upper bound critical value at the conventional level of significance we reject the null hypothesis as against the alternative hypothesis. Alternatively, if the F-statistics is lower than the I (0) (lower bound) we fail to reject the null hypothesis. When the status of cointegration among the variables have been attain, we perform various diagnostic test to validate the robustness of the model. Irrespective of the verserlity of the ARDL model in incorporating both I (0) and I (1) order of integration of the variables, it also possess other unique advantages over other estimating procedures.

To begin, the ARDL model is capable of producing statistically significant results while yet maintaining a compact and straightforward size. In contrast to other methods of cointegration estimation, the ARDL cointegration methodology allows for the lags in the variables to be in any order. Other cointegration estimation techniques demand that the lags all be in the same order. In contrast to other models, which utilize a variety of different equations, the ARDL model simply employs a single equation derived from the OLS estimation approach.

Because of the distinctive qualities of the ARDL model, we make use of the NARDL model to examine the impact of asymmetry in the independent variables has on the variables that are being investigated. The conditional error correction framework is presented further down.

6.1.8 Nardl Model with Negative and Positive Partial Sum Decomposition

$$\Delta CO2_t = \alpha + \sum_{i=1}^{P0}(\beta_{0,j} \cdot \Delta CO2_{t-i}) + \sum_{j=0}^{P_1^+}(\beta_{1,j}^+ \cdot \Delta FDI_{t-j}^+) + \sum_{j=o}^{P_1^-}(\beta_{1,j}^- \cdot \Delta FDI_{t-j}^-)$$
$$+ \sum_{k=o}^{P_2^+}(\beta_{2,k}^+ \cdot \Delta GDP_{t-k}^+) + \sum_{k=o}^{P_2^-}(\beta_{2,k}^- \cdot \Delta GDP_{t-k}^-) + \sum_{l=0}^{P_3^+}(\beta_{3,l}^+ \cdot \Delta EC_{t-l}^+)$$
$$+ \sum_{l=0}^{P_3^-}(\beta_{3,l}^- \cdot \Delta EC_{t-l}^-) + \sum_{m=0}^{P_4^+}(\beta_{4,m}^+ \cdot \Delta UPG_{t-m}^+) + \sum_{m=0}^{P_4^-}(\beta_{4,m}^- \cdot \Delta UPG_{t-m}^-)$$
$$+ \lambda_0 \cdot CO2_{t-1} + \lambda_1^+ \cdot FDI_{t-1}^+ + \lambda_1^- \cdot FDI_{t-1}^- + \lambda_2^+ \cdot GDP_{t-1}^+ + \lambda_2^- \cdot GDP_{t-1}^-$$
$$+ \lambda_3^+ \cdot EC_{t-1}^+ + \lambda_3^- \cdot EC_{t-1}^- + \lambda_4^+ \cdot UPG_{t-1}^+ + \lambda_4^- \cdot UPG_{t-1}^- + \varepsilon_t \qquad (10)$$

The above equation GDP represent Gross Domestic Product growth rate, FDI represent Foreign Direct Investment, CO2 represent Carbon dioxide emissions in metric tons, EC represent energy consumption and UPG represent Urban Population Growth (Annual). The ‘’+’’ and the ‘’- ‘’ signs of the explanatory variables represent the positive and negative partial sum decomposition.

$$FDI_t^+ = \sum_{i=1}^{t} \Delta FDI_i^+ = \sum_{i=1}^{t} \max(\Delta FDI_{i,} 0)$$

$$FDI_t^- = \sum_{i=1}^{t} \Delta FDI_i^- = \sum_{i=1}^{t} \min(\Delta FDI_i, 0)$$

$$GDP_t^+ = \sum_{i=1}^{t} \Delta GDP_i^+ = \sum_{i=1}^{t} \max(\Delta GDP_i\,, 0)$$

$$GDP_t^- = \sum_{i=1}^{t} \Delta GDP_i^- = \sum_{i=1}^{t} \min(\Delta GDP_i, 0$$

$$EC_t^+ = \sum_{i=1}^{t} \Delta EC_i^+ = \sum_{i=1}^{t} \max(\Delta EC_i, 0)$$

$$EC_t^- = \sum_{i=1}^{t} \Delta EC_I^- = \sum_{i=1}^{t} \min(\Delta EC_i, 0)$$

$$UPG_t^+ = \sum_{i=1}^{t} \Delta UPG_i^+ = \sum_{i=1}^{t} \max(\Delta UPG_i, 0)$$

$$UPG_t^- = \sum_{i=1}^{t} \Delta UPG_i^- = \sum_{i=1}^{t} \min(\Delta UPG_i, 0) \qquad (11)$$

6.1.9 Conclusion

In this section, we evaluate the many techniques and analyses already present in the relevant literature.

Table 1 summarizes the variables, procedures, and results that were used. The subsections elaborate on the various types of unit root tests and cointegration tests, as well as the justifications for using them. In this chapter, we look at the ARDL models, one of the most popular models in the academic literature. After the ARDL model has been specified, we may proceed to use the Granger causality test. Through this analysis, we can ascertain which way causes affect the other. The Pooled Mean Group estimator is often used to estimate coefficients in articles that use the ARDL model.

By comparing the publications' findings, we see that there are in fact conflicting conclusions, which lends credence to the importance of this concept. Based on this chapter's evaluation of relevant literature, the ARDL model seems to be the best fit for this thesis. This is especially true since the dependent variable in this thesis is carbon dioxide (CO2), and not any other connection between variables.

So, it's safe to assume that a single model will enough to address the inquiry. Another benefit of the ARDL model is that it allows for consistent estimators to be constructed even when using variables with both the I (0) and I (1) values.

CHAPTER VII

7.1.0 Empirical Result

The chapter is comprised of a detailed presentation of the findings obtained from this research, including descriptive statistics, the unit root test, the NARDL bound test, the Lag length selection criterion, the NARDL Long Run and Short Run estimated results, and all other diagnostics tests that improve the reliability and precision of the study.

	CO2	EC	FDI	GDP	UPG
Mean	**0.115854**	**0.014418**	**-1.09E+08**	**2.478678**	**3.041970**
Median	**0.110000**	**0.012180**	**-10413410**	**3.464600**	**3.248860**
Maximum	**0.200000**	**0.115350**	**1.40E+08**	**26.41730**	**5.300357**
Minimum	**0.030000**	**0.006402**	**-9.50E+08**	**-20.59880**	**0.251402**
Std.dev	**0.039559**	**0.016396**	**2.13E+08**	**8.329434**	**1.280996**
Skewness	**0.207109**	**5.887376**	**-2.278947**	**-0.155264**	**-0.680025**
Kurtosis	**2.551386**	**36.80738**	**8.451304**	**5.342861**	**2.922042**
J. Bera	**0.636920**	**2189.372**	**86.25565**	**9.541772**	**3.170347**
Probability	**0.727268**	**0.000000**	**0.000000**	**0.008473**	**0.204912**
Sum sq.dev	**0.062595**	**0.010753**	**1.82E+18**	**2775.179**	**65.63805**
observation	**41**	**41**	**41**	**41**	**41**

Table 2: Descriptive statistics.

7.2.0 Descriptive statistics

The summary statistics for the variables that were used in this investigation are presented in the table that can be found above. These statistics include the minimum and maximum values, the standard deviation, skewness and kurtosis, mean and median values, as well as Jacque Bera and probability values. According to the data shown above, negative skews are found in foreign direct investments, gross domestic product growth, and urban population growth, but positive skews are found in CO_2 emissions and energy consumption. This means that negative skews are found on the left side of the graph. Additionally, the result demonstrates that C02 and UPG are leptokurtic, which means that their kurtosis values are less than 3, while EC, FDI, and GDP are stated to be platykurtic.

7.3.0 Unit Root Test

AUGMENTED DICKEY FULLER TEST (ADF)			**PHILIPS PERRON TEST (PP)**		**DECISION**
VARIABLE	**LEVEL**	**FIRST DIFFERENCE**	**LEVEL**	**FIRST DIFFERENCE**	**ORDER OF INTEGRATION**
CO2	**-2.229410 (0.1995)**	**-7.884747 (0.0000) ***	**-2.129922 (0.2345)**	**-7.884747 (0.0000) ***	**I (1)**
EC	**-6.320314 (0.0000)***	**-10.51242 (0.0000)**	**-6.320314 (0.0000)***	**-37.66997 (0.0001)**	**I (0)**
FDI	**-2.417406 (0.1435)**	**-6.660167 (0.0000) ***	**-2.437749 (0.1382)**	**-6.883634 (0.0000) ***	**I (1)**
GDP	**-5.697244 (0.0000)***	**-10.25413 (0.0000)**	**-5.702995 (0.0000)***	**-6.883634 (0.0001)**	**I (0)**
UPG	**-3.345455 (0.0196)****	**-3.152520 (0.0308)**	**-1.943064 (0.3100)**	**-3.238739 (0.0251)**	**I (0)**

Table 3: UNIT ROOT TEST.

We examine whether or not the variables become stationary by taking the first difference between them. Stationarity is shown by the symbols I(1) and I(0), which stand for first difference and level, respectively. The ADF stationarity tests and the PP stationarity tests were executed. We are also able to establish the sequence in which the variables are included into the process. In order to guarantee that no variable integrates at a higher order than one, we must take this precaution.

The unit root results for all of the variables in level and first difference are shown in Table 2. It is essential, in order to prevent the production of results that cannot be relied upon, that the variables that are going to be utilized in this investigation undergo testing to determine the stationarity levels of those variables, and that those variables not be integrated at their second difference. I (2). (2). According to the outcome of the ADF and PP test, energy consumption, economic growth, and urban population growth are all integrated at level (I (0)) at a significance level of 1% for both EC and GDP, and at a significance level of 5% for UPG. Both FDI and CO2 are included at the first difference level, which is set at 1% significant level.

7.4.0 Lag Length

As a dynamic model, the ARDL takes into consideration the interplay of its variables across time periods other than its own. Therefore, it's important to figure out how long each variable should lag before being considered. The Akaike Information Criterion may be used to determine the ideal lag time (AIC).

In the ARDL model, the order of lags is decided by either the Akaike information criterion (AIC) or the Schwarz criterion (SC). Akaike Information Criteria chose the most appropriate lag between observations in this study.

From the result obtain from the AIC the optimal lag length is ARDL (3,0,1,0,3)

7.5.0 Nardl Co-Integration Bound Test

F Statistics	**10%**		**5%**		**2.5%**		**1%**	
	I (0)	**I (1)**	**I (0)**	**I (1)**	**I (0)**	**I (1)**	**I (0)**	**I (1)**
7.358444	**1.85**	**2.85**	**2.11**	**3.15**	**2.33**	**3.42**	**2.62**	**3.77**

Table 4: NARDL BOUND TEST

The ADF test established the presumption that the ARDL (NARDL) model should be used. In order to determine whether or not the variables have a cointegrating connection over the long run, we use the NARDL bound test that was developed by Shin et al. (2014). The decision rule that states that we are to reject the null hypothesis of no cointegration and accept the alternative hypothesis if the value of the F-statistics is greater than the upper limit I (1) critical value. However, if the value of the F-statistics is found to be less than the lower limit I (0), then our attempt to reject the null hypothesis will be unsuccessful. On the other hand, the choice is considered to be inconclusive if the value of the F-statistics falls anywhere in the middle of the upper and lower bounds. The results of the cointegration bound test are provided in table 3, and those results show that the value of the F-statistics (7.358444), which is significantly greater than the upper limit I (1) value (3.15), even at the standard significant level of 5%. The above finding lends credence to the notion that there is, in the long term, a link between the variables.

7.6.0 Long Run Nardl

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	**0.345489**	**0.818239**	**0.422235**	**0.6776**
C02(-1)	**-1.033614**	**0.169203**	**-6.108725**	**0.0000**
EC_POS	**-7.790981**	**6.254001**	**-1.245760**	**0.2280**
EC_NEG	**-6.530978**	**2.719057**	**-2.401928**	**0.0267**
FDI_POS	**1.57E-10**	**6.81E-11**	**2.310337**	**0.0323**
FDI_NEG	**-2.63E-11**	**5.76E-11**	**-0.455762**	**0.6537**
GDP_POS	**-0.002232**	**0.000654**	**-3.413530**	**0.0029**
GDP_NEG	**0.001882**	**0.000902**	**2.087669**	**0.0505**
UPG_POS	**0.043786**	**0.010679**	**4.100229**	**0.0006**
UPG_NEG	**-0.015141**	**0.006471**	**-2.339691**	**0.0304**

Table 5: LONG RUN RESULT

Table 4 presents the findings of the NARDL model's long run asymmetry analysis at the 5% conventional level of significance. The result shown above validates the presence of the table. Although the conclusion is not statistically significant, it demonstrates that a reduction in CO2 emissions will follow a trajectory of increasing energy consumption that is beneficial. On the other hand, a negative impact on energy consumption would result in an increase in the amount of CO_2 emissions. This means that a reduction of only one unit in energy consumption will result in a reduction of 6.531 units in CO_2 emissions. In the long run, the result demonstrates that positive shocks to energy consumption have a statistically significant effect on CO_2 emission, whereas negative shocks to energy consumption increase CO_2 emission. This was determined by examining the relationship between positive and negative energy consumption shocks. The study also shows that a positive shock on foreign direct investment led to an increase in CO_2 emission, whereas negative shocks do not have a statistically meaningful impact on the situation. Both a positive and negative shock to GDP will lead to a drop in CO_2 emissions, but both a positive and negative growth in urban population will lead to a statistically significant increase in CO_2 emissions.

7.7.0 Short Run Nardl

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D(FDI_POS)	**-6.38E-11**	**3.48E-11**	**-1.834322**	**0.0823**
D(FDI_NEG)	**1.04E-10**	**2.15E-11**	**4.838924**	**0.0001**
D(GDP_POS)	**-0.000783**	**0.000277**	**-2.825567**	**0.0108**
D(GDP_NEG)	**0.000664**	**0.000260**	**2.560300**	**0.0191**
D(UPG_POS)	**-0.065426**	**0.009652**	**-6.778232**	**0.0000**
D(UPG_NEG)	**0.050671**	**0.007071**	**7.165648**	**0.0000**
CointEq(-1)*	**-0.133614**	**0.009100**	**-14.68286**	**0.0000**

Table 6: SHORT RUN RESULT

The results of the short run indicate that both an increase and a drop in FDI are required to bring about a reduction in CO_2 emissions. Based on the findings, it is clear that a one-unit rise in FDI will result in a 6.38-unit reduction in CO_2 emission, and a one-unit decline in FDI would result in a 1.04-unit increase in CO_2 emission. Additionally, the conclusion demonstrates that a statistically significant relationship exists between a positive and a negative partial decomposition of GDP and a reduction in CO_2 emissions. Additionally, shocks to urban population growth, whether positive or negative, have a very important role in the overall reduction of CO_2 emissions. In the long run, any disequilibrium will, as a matter of course, be corrected by the error correct term (ECT-0.133614), which indicate the speed of adjustment 13.36%.

7.8.0 Diagnostic Test

The results of the numerous diagnostic tests that were run to assess the model's accuracy and robustness are shown in the table below. The conclusion that the model is homoscedastic may be drawn from the findings of the B.P. Godfrey test, which show that the probability value is higher than the significant threshold of 5%. In addition to this, further findings from table 6 suggest that the model is free from serial correlation, that the model has been accurately defined, and that the variables have normal distributions.

Test	**Name**	**Prob value**
Heteroscedasticity	**B.P Godfrey test**	**0.2754**
Serial correlation	**Breusch-Godfrey test**	**0.2661**
Specification	**Ramsey Reset test**	**0.1105**
Normality test	**Histogram Normality**	**0.904680**

Table 7: DIAGNOSTIC TEST RESULTS

7.9.0 Stability Test

The structural stability of regression coefficients is assessed using the cumulative sum (CUSUM). the CUSUM, as shown in Figures 3, is inside the 5% critical constraint, indicating stability in the model.

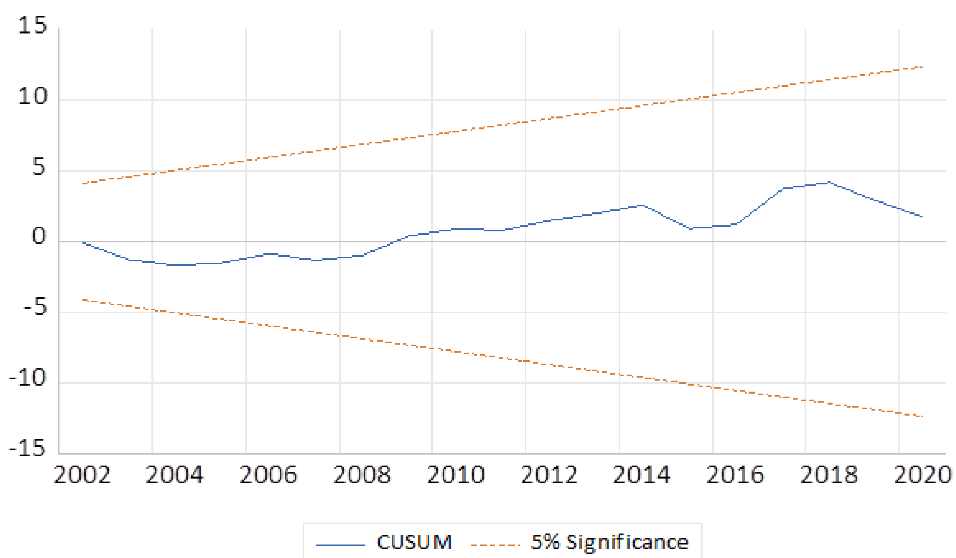

Figure 3: STABILITY TEST RESULT

CHAPTER VIII

8.1.0 Discussion of result link to the research hypothesis

In this chapter, we will talk about the findings from the econometric analysis and how they relate to the research hypothesis. The first step was to determine whether or not all of the variables have unit roots and whether or not all of the variables are stationary in levels or initial differences. Second, using the Akaike information criteria, the best lag length for both the dependent and the independent variables are derived. After that, the ARDL Bound test is executed in order to determine whether or not the data exhibit cointegration. This test was done because the variables are integrated with a mixed order of integration, which is to say that I (0) and I (1), the short-term dynamics of the model may be affected by the cointegration connection. This ECT makes certain that reliable results are achieved in the event that cointegration is present. In addition to this, the ECT also reveals whether or not cointegration can be found in the data.

This thesis is important for two reasons, both of which are mentioned at the outset of this study.

The first reason is that this thesis's variables have not been definitively linked to changes in CO2 emissions in the available research. In addition, to the best of our knowledge, this thesis's particular collection of variables has never been evaluated previously in Sierra Leone. This argument is not only important because it closes a gap in the scientific literature, but also because of the societal impact it might have. Today's politicians are well aware of the need of minimizing greenhouse gas emissions like carbon dioxide. Therefore, it is crucial to understand what variables affect the total quantity of emissions so that rules may be revised accordingly. The most striking result of the econometric analysis is not the response to the research question of this thesis, but rather the fact that the importance of the variables relies strongly on the number and/or composition of variables included in the model. Not surprisingly, higher energy use is associated with higher levels of CO2 emissions per person. Other studies (covered in Chapter 3) exclusively consider energy consumption from fossil fuels as a variable, although Riti et al. (2017) and Rafiq et al. (2016) additionally examine the impact of testing for energy consumption and non-renewable energy use, respectively. All of these factors are consistent with the conclusion of this thesis, which states that there is a positive correlation between energy use and per capita CO2 emissions.

In the long term, this leads to their being an increased number of factors that are important. Now, not only does the consumption of energy derived from fossil fuels have a considerable positive influence on the quantity of CO2 emissions per capita, but the consumption of energy derived from renewable sources also has a significant negative impact, as was to be anticipated. Additionally, GDP per capita has been shown to have a strong positive impact on CO2 emissions per capita. This suggests that an increase in GDP per capita will lead to an increase in the quantity of emissions per capita (i.e., scale effect).

The evidence supporting the EKC found in this thesis agrees with that found by Baek (2016), You et al. (2015), Tang and Tan (2015), Pao and Tsai (2011), and Boutabba (2014). Other papers, however, such as (Chandran and Tang 2013), (Zhu et al. 2016), and (Mert and Bölük 2016), do not discover evidence for the EKC. Another key correlation discovered by the authors is between a country's level of FDI influx and its level of CO2 emissions per capita. There is data suggesting a positive and a negative correlation between this variable and per capita carbon dioxide emissions. Not only in terms of comparing and contrasting with the findings of other studies, but also theoretically. In contrast to the negative prediction made by the pollution halo theory, the pollution haven hypothesis predicts a positive correlation between the two variables. Finding a negative coefficient for the FDI variable in this thesis's study provides strong evidence in favor of the pollution halo theory.

The findings indicate that in the near term, a reduction in CO2 emissions will follow both positive and negative changes in the environment. This research lends credence to the Environmental Kuznets Curve Hypothesis in Sierra Leone by arguing that a reduction in carbon dioxide emissions into the atmosphere should result from the country's efforts to advance along a path leading to higher rates of economic development. This research lends credence to the pollution haven theory in Sierra Leone since it demonstrates that fluctuations in foreign direct investment (FDI), whether positive or negative, have a mitigating impact on CO2 emissions in the short term. This is in line with the stringent laws and regulations that have been imposed by the government, which also encourages foreign and domestic companies to import sophisticated plant and machinery.

Additionally, the government has placed a ban on the importation of used cars that are older than 5 years, as well as other carbon emission prone machines and other equipment that has a high propensity for environmental degradation. To a great degree, the decline in CO2 emissions in Sierra Leone is attributable to both positive and negative shocks on the expansion of the urban population. Traditional cooking methods are becoming less common in most rural areas as a result of an increase in the proportion of the population that lives in cities.

8.2.0 Policy Recommendation

Sierra Leone should adopt strategies to enhance the level of investment in an area of energy infrastructure and the decree should be oriented on conservation and efficiency policies to enhance energy effectiveness and to minimize waste of energy consumption in order to lower its CO2 emissions. The government should increase and diversify current energy consumption, and there is a pressing need to raise public awareness about the need of reducing emissions.

To lower carbon dioxide emissions, governments worldwide should increase spending on energy-efficient infrastructure projects, such as retrofitting public transportation systems. Investment in renewable energy and the need for efficient resource usage are receiving more focus.

The amount of carbon dioxide emissions may be lowered by enforcing stricter regulations that mandate the use of energy-efficient technology and the supply of these technologies at reasonable prices.

A large portion of the aforementioned finding may be attributed to the impact of FDI on Sierra Leone emissions of greenhouse gases.

that foreign direct investment should be encouraged in Sierra Leone.

An alternative legislative step that might lead to improved environmental conditions in the area is the establishment of a fund for environmental improvement in this nation.

8.3.0 Conclusion

This thesis is organized into chapters that each focus on answering the following question: Can we determine the relative impact of FDI, wealth, and energy use on CO2 emissions? Therefore, in this last chapter, we will analyze the overall results and implications of each individual chapter, as well as provide suggestions for further study.

First, we undertake a literature study, during which time the most fundamental ideas and hypotheses about the four factors (CO2 emissions, FDI, GDP, and energy consumption) are developed and discussed. To begin, let's look at the environmental Kuznets curve, which states that as GDP per capita rises in low-income nations, so too will CO2 emissions per person. We refer to this phenomenon as the scale effect. However, when economies expand, the makeup of those economies changes from agricultural to industrial, and then to service, resulting in lower CO2 emissions per person (technique impact) and overall (composition effect). The pollution haven theory and the pollution halo hypothesis are two more hypotheses that attempt to explain the connection between FDI and CO2 emissions. In the former scenario, industrialized nations are assumed to send foreign direct investment (FDI) to emerging countries due to the latter's comparative advantage in polluting production. Due to lax environmental restrictions, countries like these see a rise in harmful output after an influx of foreign direct investment, which in turn increases their carbon dioxide emissions. However, the pollution halo hypothesis argues that nations with higher levels of FDI have less concentration of carbon dioxide (CO2) emission as a result of more environmentally friendly industrial practices. A rise in carbon dioxide emissions is often linked to the third variable, energy usage. CO2 emissions can only be lowered by switching to a less polluting energy source.

It is crucial to examine the above listed factors and their impact. For two reasons: first, policymakers aim to establish regulations that would lower emissions, and second, the research is inconsistent on the impact of the variables in total CO2 output. Therefore, gaining a better understanding of these connections is important for research and policymaking. First, a mechanism should be developed for estimating these connections. Chapter 3 evaluation of existing research methodologies is used to inform the choice of approach. The autoregressive distributed lag (ARDL) model and the vector error correction model (VECM) seem to be the best fits.

Both of these models are dynamic (i.e., they incorporate delays) and may provide simultaneous estimates of short- and long-run impacts. The VECM, in contrast to the ARDL model, makes use of a vector of dependent variables. Because CO2 emissions are the primary subject of this thesis's research topic, the ARDL model is the superior option. An additional benefit of the ARDL model is that it may be estimated using I (0), I(1), or both types of variables. There is no need to worry about inaccurate model estimates due to cointegration if the model is transformed into an ARDL model that includes an error correction term (ECT).

An optimistic link between GDP per capita and CO2 emissions per capita suggests that the EKC applies in this case. In accordance with what the environmental Kuznets curve would suggest. These findings provide a good foundation for future studies. The limitations are discussed in the earlier section, and some of them may be addressed by conducting more studies.

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APENDIX A

DESCRIPTIVE STATISTICS

	C02	EC	FDI	GDP	UPG
Mean	0.115854	0.014418	-1.09E+08	2.478678	3.041970
Median	0.110000	0.012180	-10413410	3.464600	3.248860
Maximum	0.200000	0.115350	1.40E+08	26.41730	5.300357
Minimum	0.030000	0.006402	-9.50E+08	-20.59880	0.251402
Std. Dev.	0.039559	0.016396	2.13E+08	8.329434	1.280996
Skewness	0.207109	5.887376	-2.278947	-0.155264	-0.680025
Kurtosis	2.551386	36.80738	8.451304	5.342861	2.922042
Jarque-Bera	0.636920	2189.372	86.25565	9.541772	3.170347
Probability	0.727268	0.000000	0.000000	0.008473	0.204912
Sum	4.750000	0.591129	-4.46E+09	101.6258	124.7208
Sum Sq. Dev.	0.062595	0.010753	1.82E+18	2775.179	65.63805
Observations	41	41	41	41	41

AUGMENTED DICKEY FULLER UNIT ROOT TEST (LEVEL)

CO2 EMISSIONS

Null Hypothesis: C02 has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.229410	0.1995

Test critical values:	1% level	-3.605593
	5% level	-2.936942
	10% level	-2.606857

*MacKinnon (1996) one-sided p-values.

ENERGY CONSUMPTION

Null Hypothesis: EC has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.320314	0.0000
Test critical values:	1% level	-3.605593	
	5% level	-2.936942	
	10% level	-2.606857	

*MacKinnon (1996) one-sided p-values.

FOREIGN DIRECT INVESTMENT

Null Hypothesis: FDI has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.417406	0.1435

Test critical values:	1% level	-3.605593	
	5% level	-2.936942	
	10% level	-2.606857	

*MacKinnon (1996) one-sided p-values.

GROSS DOMESTIC PRODUCT

Null Hypothesis: GDP has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.697244	0.0000
Test critical values:	1% level	-3.605593	
	5% level	-2.936942	
	10% level	-2.606857	

*MacKinnon (1996) one-sided p-values.

URBAN POPULATION GROWTH

Null Hypothesis: UPG has a unit root

Exogenous: Constant

Lag Length: 2 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.345455	0.0196
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	

10% level	-2.609066	

*MacKinnon (1996) one-sided p-values.

AUGMENTED DICKEY FULLER UNIT ROOT TEST (FIRST DIFFERENCE)

CO2 EMISSIONS

Null Hypothesis: D(C02) has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.884747	0.0000
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

*MacKinnon (1996) one-sided p-values.

ENERGY CONSUMPTION

Null Hypothesis: D(EC) has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.51242	0.0000
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

*MacKinnon (1996) one-sided p-values.

FOREIGN DIRECT INVESTMENT

Null Hypothesis: D(FDI) has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.660167	0.0000
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

*MacKinnon (1996) one-sided p-values.

GROSS DOMESTIC PRODUCT

Null Hypothesis: D(GDP) has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.25413	0.0000
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

*MacKinnon (1996) one-sided p-values.

URBAN POPULATION GROWTH

Null Hypothesis: D(UPG) has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.152520	0.0308
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

*MacKinnon (1996) one-sided p-values.

PHILIPS PERRON UNIT ROOT TEST (LEVEL)

CO2 EMISSIONS

Null Hypothesis: C02 has a unit root

Exogenous: Constant

Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.129922	0.2345
Test critical values:	1% level	-3.605593	
	5% level	-2.936942	
	10% level	-2.606857	

*MacKinnon (1996) one-sided p-values.

ENERGY CONSUMPTION

Null Hypothesis: EC has a unit root

Exogenous: Constant

Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.320314	0.0000
Test critical values:	1% level	-3.605593	
	5% level	-2.936942	
	10% level	-2.606857	

*MacKinnon (1996) one-sided p-values.

FOREIGN DIRECT INVESTMENT

Null Hypothesis: FDI has a unit root

Exogenous: Constant

Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.437749	0.1382
Test critical values:	1% level	-3.605593	
	5% level	-2.936942	
	10% level	-2.606857	

*MacKinnon (1996) one-sided p-values.

GROSS DOMESTIC PRODUCT

Null Hypothesis: GDP has a unit root

Exogenous: Constant

Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.702995	0.0000
Test critical values:	1% level	-3.605593	
	5% level	-2.936942	
	10% level	-2.606857	

*MacKinnon (1996) one-sided p-values.

URBAN POPULATION GROWTH

Null Hypothesis: UPG has a unit root

Exogenous: Constant

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.943064	0.3100
Test critical values:	1% level	-3.605593	
	5% level	-2.936942	
	10% level	-2.606857	

*MacKinnon (1996) one-sided p-values.

PHILIPS-PERRON UNIT ROOT TEST (FIRST DIFFERENCE)

CO2 EMISSIONS

Null Hypothesis: D(C02) has a unit root

Exogenous: Constant

Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

	Adj. t-Stat	Prob.*
Phillips-Perron test statistic	-7.884747	0.0000

Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

*MacKinnon (1996) one-sided p-values.

ENERGY CONSUMPTION

Null Hypothesis: D(EC) has a unit root

Exogenous: Constant

Bandwidth: 38 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-37.66997	0.0001
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

*MacKinnon (1996) one-sided p-values.

FOREIGN DIRECT INVESTMENT

Null Hypothesis: D(FDI) has a unit root

Exogenous: Constant

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.883634	0.0000
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

*MacKinnon (1996) one-sided p-values.

GROSS DOMESTIC PRODUCT

Null Hypothesis: D(GDP) has a unit root

Exogenous: Constant

Bandwidth: 29 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-29.35451	0.0001
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

*MacKinnon (1996) one-sided p-values.

URBAN POPULATION GROWTH

Null Hypothesis: D(UPG) has a unit root

Exogenous: Constant

Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.238739	0.0251
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

*MacKinnon (1996) one-sided p-values.

NARDL BOUND TEST

F-Bounds Test			Null Hypothesis: No levels relationship	
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	7.358444	10%	1.85	2.85
k	8	5%	2.11	3.15
		2.5%	2.33	3.42
		1%	2.62	3.77
			Finite Sample: n=40	
Actual Sample Size	38			
		10%	-1	-1
		5%	-1	-1
		1%	-1	-1
			Finite Sample: n=35	
		10%	-1	-1
		5%	-1	-1
		1%	-1	-1

NARDL LONG RUN (Dependent Variable: CO2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.345489	0.818239	0.422235	0.6776
C02(-1)	-1.033614	0.169203	-6.108725	0.0000

EC_POS	-7.790981	6.254001	-1.245760	0.2280
EC_NEG	-6.530978	2.719057	-2.401928	0.0267
FDI_POS	1.57E-10	6.81E-11	2.310337	0.0323
FDI_NEG	-2.63E-11	5.76E-11	-0.455762	0.6537
GDP_POS	-0.002232	0.000654	-3.413530	0.0029
GDP_NEG	0.001882	0.000902	2.087669	0.0505
UPG_POS	0.043786	0.010679	4.100229	0.0006
UPG_NEG	-0.015141	0.006471	-2.339691	0.0304

NARDL SHORT RUN (Dependent Variable: CO_2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(FDI_POS)	-6.38E-11	3.48E-11	-1.834322	0.0823
D(FDI_NEG)	1.04E-10	2.15E-11	4.838924	0.0001
D(GDP_POS)	-0.000783	0.000277	-2.825567	0.0108
D(GDP_NEG)	0.000664	0.000260	2.560300	0.0191
D(UPG_POS)	-0.065426	0.009652	-6.778232	0.0000
D(UPG_NEG)	0.050671	0.007071	7.165648	0.0000
CointEq(-1)*	-0.133614	0.099100	-14.68286	0.0000

HETEROSCEDASTICITY TEST

Heteroskedasticity Test: Breusch-Pagan-Godfrey

Null hypothesis: Homoskedasticity

F-statistic	1.275646	Prob. F(12,24)	0.2940
Obs*R-squared	14.40904	Prob. Chi-Square(12)	0.2754
Scaled explained SS	6.922441	Prob. Chi-Square(12)	0.8627

SERIAL CORRELATION LM TEST

Breusch-Godfrey Serial Correlation LM Test:

Null hypothesis: No serial correlation at up to 2 lags

F-statistic	0.847764	Prob. F(2,22)	0.4419
Obs*R-squared	2.647528	Prob. Chi-Square(2)	0.2661

Ramsey RESET Test

Equation: UNTITLED

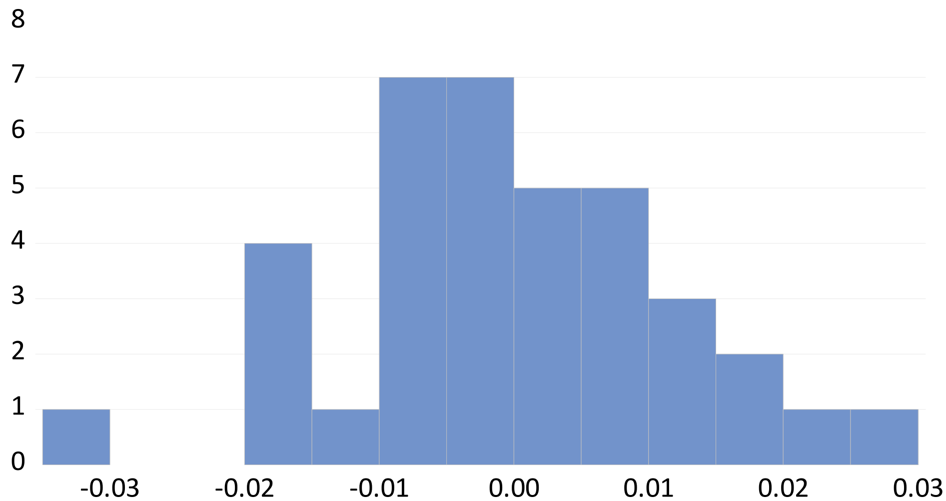
Omitted Variables: Squares of fitted values

Specification: C02 C02(-1) EC EC(-1) EC(-2) EC(-3) EC(-4) FDI FDI(-1)

FDI(-2) GDP UPG UPG(-1) C

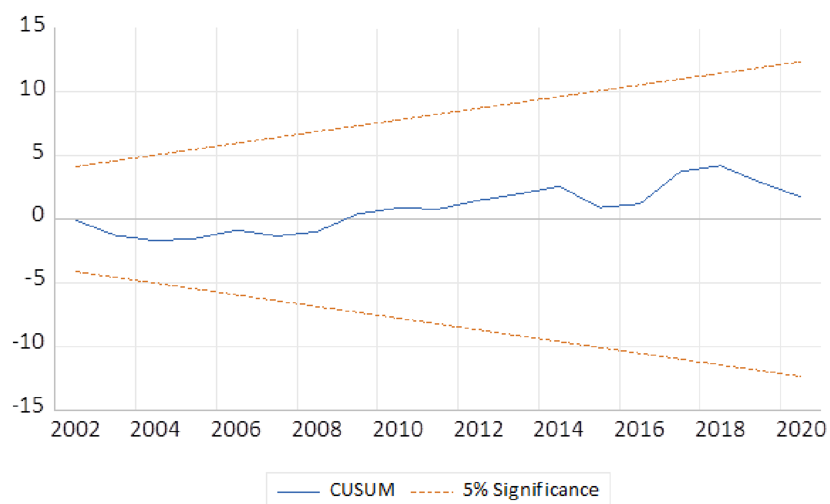
	Value	df	Probability
t-statistic	1.659829	23	0.1105
F-statistic	2.755032	(1, 23)	0.1105
Likelihood ratio	4.186025	1	0.0408

HISTOGRAM NORMALITY TEST



Series: Residuals	
Sample 1984 2020	
Observations 37	
Mean	-2.08e-17
Median	-0.000841
Maximum	0.028044
Minimum	-0.030775
Std. Dev.	0.012003
Skewness	-0.111221
Kurtosis	3.283680
Jarque-Bera	0.200347
Probability	0.904680

STABILITY TEST



Thesis

ORIGINALITY REPORT

11%	8%	7%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	edepot.wur.nl Internet Source	2%
2	aloki.hu Internet Source	1%
3	www.scirp.org Internet Source	1%
4	energypedia.info Internet Source	1%
5	www.researchgate.net Internet Source	<1%
6	Submitted to Higher Education Commission Pakistan Student Paper	<1%
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8	Rana Ejaz Ali Khan, Qazi Muhammad Adnan Hye. "Foreign direct investment and liberalization policies in Pakistan: An empirical analysis", Cogent Economics & Finance, 2014 Publication	<1%

NEAR EAST UNIVERSITY

SCIENTIFIC RESEARCH ETHICS COMMITTEE

21.11.2022

Dear Alhassan Turay

Your project **"The dynamic relationship between Co2 emissions, GDP, Urban population, Energy consumption and Foreign direct investments in Sierra Leone. Using environmental Kurznet curve hypothesis."** has been evaluated. Since only secondary data will be used the project 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

The Coordinator of the Scientific Research Ethics Committee

ALHASSAN TURAY

32 Caulker Street, **Email:**
turayalhassan10@gmail.com
Wellington, Freetown. **Contact:**
+23277374079

OBJECTIVE: To obtain a full time position in a public or private institution which offers a professional working environment that enhance career development and while meeting the institution's goals.

PERSONAL SUMMARY: An assiduous, resourceful and ambitious economist with understanding of economic theory and policies and it practical implications. Possesses the ability to undertake analytic work, multi-tasking and research project with minimal supervision, whilst working in a team environment with multiple priorities and tight deadlines. With the zest of active commitment to continuous improving quality standard when performing an assign task. Possessing an ability to communicate complex and sensitive information in an understandable form that aids easy comprehension to colleagues and clients.

Would like to work for a successful organization that rewards achievements and offer great opportunities for career development.

EDUCATION

YEAR	GRADE ACHIEVED	INSTITUTION
2021-2022	**MSc Economics (Higher Honors 3.64/4.0)**	**Near East University**
2015-2019	**Bsc Economics (Div 1 GPA 3.43/4.0)**	**Fourah Bay College**

RELATED MODULES

- Elementary Statistical Methods
- Elements of Economics

- Quantitative Methods
- Applied Economics
- Advance Macroeconomic Theory
- Labor Economics
- Macroeconomics
- Microeconomics
- Development Economics
- Advance Microeconomic Theory
- International Economics

2009-2012 **WASSCE**

Albert Academy

2006-2009 **BECE**

Albert Academy

KEY COMPETENCIES AND SKILLS

- ✓ Decision making
- ✓ Statistical Research
- ✓ Attention to details
- ✓ Statistical and quantitative skills
- ✓ Time management skills
- ✓ Computer literacy

PERSONAL ATTRIBUTE

- ❖ Excellent communication and interpersonal skills.
- ❖ Very good internal and external relationship building skills
- ❖ Ability to operate effectively with a high level of autonomy
- ❖ Dedicated to financial integrity and cost effectiveness
- ❖ Inspired and innovative
- ❖ Empowering others and respecting differences
- ❖ Ability to show flexibility, initiative and innovation when dealing with challenging situation.

- ❖ Intellectual curiosity.

WORK EXPERIENCE

YEAR INSTITUTION

POSITION

MARCH 2018 NATIONAL ELECTORAL COMMISSION

PRESIDING OFFICER

Main duties

- ➢ Manages the assign polling station
- ➢ Train polling staff (together with polling center manager)
- ➢ Supervised polling staff to ensure the integrity and procedural accuracy of the polling operations
- ➢ Count ballots at the polling station
- ➢ Ensure that all documentation required for the polling station was completed correctly.

DECEMBER 2015 STATISTICS SIERRA LEONE

ENUMERATOR

Main duties

- ➢ Conduct an extensive visual survey of my assigned enumerated area few days prior to the start of the census.
- ➢ Collect all information required on the questionnaire within a specific time frame from residents in the assigned enumerated area.
- ➢ Collate and summarized comprehensively all information recorded and present to the supervisor.

2014 NATIONAL EBOLA RESPONSE CENTRE

CONTACT TRACER

Main duties

- ➢ Identify people with Ebola related symptoms and report to the appropriate health authorities.

- Monitor on a daily basis all suspected cases and quarantine homes to evaluate progress on recoveries and report to the appropriate health authorities.

2012 ACTION AGAINST HUNGER SUPERVISOR (VOLUNTEER)

Main duties

- Provide supervisory support to Action against Hunger in instituting community cleaning program in local communities around wellington to help contain the wide spread of cholera.

HOBBIES AND INTEREST

- In my spare time, I enjoy meeting up with friends to watch local and international football games either at the cinema or local community playing field. Love listening to music and watch or read newspapers to keep myself abreast with issues nationally and internationally

Referees

- Dr Abu Bakarr Tarawalie: Senior Lecturer Fourah Bay College U.S.L +23276158355
- Mr. Alusine Kamara: Senior Banking Officer, Banking of Sierra Leone +23277241409
- Asst. Prof. Dr. Mehdi Seraj Senior Lecturer Near East University +905338731432