Green Finance and Renewable Energy Use; Could Effective Mechanism Neutralize the Environmental Pollution and Enhanced the Energy Efficiency?

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List of Abbreviations

GFN	Green Finance
URB	Urbanization
EE	Energy efficiency
REU	Renewable energy use
NRR	Natural Rent Resources
EG	Economic growth
IT	International trade
FDI	Foreign direct investment
FD	Financial development
EVP	Environmental pollution
EQ	Environmental quality
OECD	Organization for Economic Co-operation and Development
WDI	World bank indicator
IEA	International Energy Agency
EC	Energy consumption
FF	Fossils Fuels
SDG	Sustainable development goals

ABSTRACT

The pursuance of green growth has become a global priority as societies recognize the need to strike a balance between economic development, environmental preservation, along with energy efficiency. Green finance has emerged as a crucial mechanism for promoting sustainable practices and mitigating the negative effects of economic activities in this context. The purpose of this study is to examine the intricate connections among green finance, economic factors, energy efficiency, along with environmental pollution in order to identify the path to sustainable development. In order to accomplish our goals, Researcher analyze a vast data set containing 79 countries from 1999 to 2019. The study employ advanced econometric techniques, such as FMOLS, Granger causality tests, and cointegration analysis, to evaluate the relationships between the variables. In addition, the study identifies mediation along with moderation effects, thereby revealing the indirect as well as interactive influences of particular variables on dependent variables.

Green finance plays a crucial role in promoting long-term economic development, fostering improved energy efficiency, and contributing to environmental preservation, according to our findings. The study illustrates how green finance can function as a catalyst for sustainable development, not only benefiting the environment but also driving economic growth. This study's findings have substantial implications for policymakers, enterprises, and other stakeholders. The incorporation of green finance into policy frameworks can result in a more resilient, environmentally conscious, and energy-efficient global economy. By recognizing the mediating and moderating effects of particular variables, decision-makers can develop targeted strategies to address environmental challenges and promote economic growth. While this research provides valuable insights, Researcher recognize its limitations, especially in terms of the availability of data and its scope. Green finance, economic factors, energy efficiency, along with environmental preservation have complex interrelationships that require additional research to investigate additional dimensions and refine understanding.

Keywords: *Green Finance, Energy Efficiency, Environmental Pollution, Financial Development, Foreign Direct Investment, Renewable Energy Use.*

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

In retrospect, cleaner production was first introduced by the United Nations Environment Protection (UNEP) in 1990. It is defined as "the continuous application of an integrated environmental strategy to processes, products, and services to increase efficiency and reduce risks to humans and the environment." Since then, the global society has changed its production procedures after realising the advantages of cleaner production. For instance, China shut down 57,000 tiny industries that polluted waters with effluent material. Global efforts are being made to pursue ecological sustainability while reducing the effects of environmental degradation. The change of energy structure is speeding up in relation to achieving global carbon neutrality. More and more countries are actively introducing laws and programmes to stimulate the expansion of the renewable energy sector which has bright possibilities. Since there has been increasing agreement regarding the need for worldwide climate change action and low-carbon energy. The world's energy demand is always rising and because of the devastating results for world climate degradation, it is the major challenges of twenty-first century (Umar et al., 2022 and Liu et al., 2021). Since 1995, the “International Energy Agency” (IEA) has observed energy consumption of 50% in worldwide (IEA, 2013). Fossil fuels (FF) supply 80% in energy consumption of the world that makes energy sector an important contributor to greenhouse gas (GHG) emissions (IEA, 2013), which account for almost two-thirds of all emissions globally (Umar et al., 2021). Improving energy efficiency is one of the top priorities on the global agenda today for the economies. Numerous emerging economies are expanding very quickly, and as a result, energy demand is rising. Since practically all commodities and services require the energy in their production process, it is important to comprehend the factors that influence the demand of energy. As a result of the COVID-19 epidemic and the global economic crisis, continuing investment in renewable energy, energy efficiency, and other green efforts drastically fell in 2020–21. The COVID-19 epidemic and economic downturns both contributed to a sharp decline in oil and petrol prices. According to the study of BloombergNEF (BNEF), businesses, governments, and consumers spent $303.5 billion in new clean energy capacity in 2020, up 2% from the previous year. This increase was made possible by the largest-ever expansion of solar projects with a $50 billion increase in offshore wind investments. Additionally, a record-breaking $139 billion, a 28% increase, was invested on electric vehicles and related charging infrastructure (Bloomberg, 2020).

Figure 1.1 Energy Transition Investment

(Source: BloombergNEF, 2020)

Despite the fact that there is a large body of work that experimentally examines investments in renewable energy while evaluating the significance of several economic, financial, and environmental indices. In contrast to the highly researched topic of carbon dioxide (environmental pollution) and climate change in recent decades, green finance is the area of interest for policy-makers who want sustainable economic growth and the environment. Nevertheless, there is a strong correlation between environmental and economic growth, as well as green finance and other factors. However, just a handful of the problems raised in this study require empirical research. First, does green finance encourage the purchase of renewable energy? In general, studies have found a positive correlation between economic growth and renewable energy investments (He et al., 2019; Zhou et al., 2020a, Zhou et al., 2020b; Li et al., 2021). An increase in the economy causes the country to structurally transition from non-renewable energy sources to renewable energy sources. One of the biggest barriers to the expansion of renewable energy is a shortage of funding (Sachs et al., 2019). Coal and oil continued to receive the majority of investment in the global energy sector as of 2018. For instance, while only receiving 19% of investments in the entire energy industry, renewable energy garnered 39% of investments in the production of electricity (International Energy Agency, 2019). The balance of the investments are going to nuclear, biofuels, or battery storage, all of which are also sources of greenhouse gas (GHG) emissions, albeit to a smaller extent. In comparison, fossil fuels received around 60% of all investments that same year (International Energy Agency, 2019).

Solar, wind, bio-fuels, nuclear, and hydro-power are some of the REU sources. So after the industrial revolution, it has been noted that every country is striving for high economic growth by using its sources of energy; however, the vast use of fossil fuels has created an urgent issue due to excessive wide spread carbon emissions, which ended up causing the sea level to rise by an additional 10–20 cm than anticipated (Nnaji et al., 2013; Naz, S. et al., 2019). Higher levels of economic growth cause the energy sector to shift from non-renewable to renewable sources, which may also increase the involvement of private investors. In the 21st century, the world's air temperature increased from 1.0° to 3.5°. This worrying situation has led nations to focus on REU sources, which are essential to achieving sustainable development worldwide. This study adds to a number of previously published literary works. In this analysis, the following research issues are prioritized. Does FD moderates the conditional indirect effect of Green finance (GFN), FDI and other economic variables on environmental pollution through renewable energy use? How much did moderating and mediating factors, like FD and REU influence on GFN, FDI, and other economic variables to have an impact on environmental pollution? There is no easy solution, but there are hints and cues Researcher can use to build a plausible story about how this will pan out.

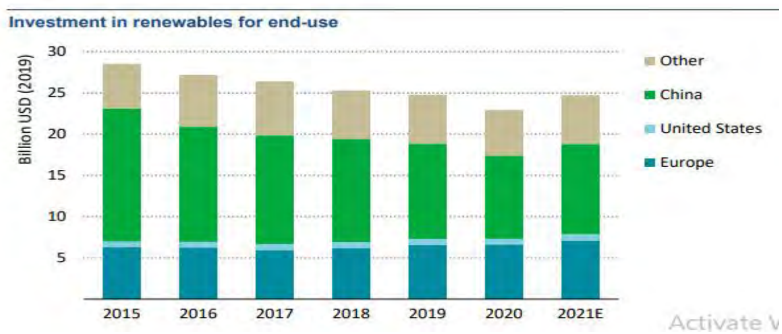
Researchers stress the importance of achieving sustainable economic growth and putting sustainable environmental policies in place. Few researchers have connected economics and ecology up until now. According to Wang and Zhi (2016), creating financing for solar energy can help achieve environmental sustainability. Based on early indications, some analysts believe the latter is possible. Undoubtedly, the year 2022 concluded in an intriguing and unsettling position. The three-year-old global pandemic, which sickened millions and had an impact on economies, demonstrated that it was far from over. In 2022, global inflation rose to 9%, the highest amount since 2008. Millions of people were uprooted by Russia's invasion of Ukraine, which had an impact on the food and energy systems. Additionally, the effects of climate change, such as the fatal floods in Pakistan, the sweltering heat in India, and the drought in Africa, increased the threat. The poor were most severely affected. In 2022 alone, up to 95 million individuals were forced into poverty. Not all the news was bad, the capacity for renewable energy increased by 8% last year, and all nations joined a historic UN biodiversity commitment to protect 30% of the world's land and water by 2030. Through the IEA (2023), the plan of REPowerEU (Joint European action on renewable energy and energy efficiency) for E.U increased its renewable energy targets from 40% to 45% of total capacity by 2030 in 2022. The bloc's emissions reduction goal was recently raised by leaders from 55% to 57% by 2030. And surveys reveal that 83% of European Union citizens believe that investing in renewable energy is now more crucial as a result of Russia's invasion of Ukraine. Outside of Europe, nations like China and India are continuing to invest in renewable energy sources even as they increase their reliance on other fossil fuels, putting this issue at a turning point this year. By 2030, $5.2 trillion in climate finance will be needed to support a low-carbon transition that is healthy for both people and the environment. The overall amount of climate finance was only $600 billion in 2020 (Climate, 2020).

Figure 1.2 Progress toward 2030 target for Global Climate Finance

(Source: State of Climate Action,2021)

Powerful institutions include banks, investment companies, international funds, development organizations, and government ministries. They influence our collective future by deciding which economic activity receives investment and which don't through their financial actions. However, these institutions still pour too much money into unsustainable and harmful activities that jeopardize the health and wellbeing of communities. Global investments in oil and gas and coal supply totaled more than $76 billion in 2020. However, nations are still tens of billions of dollars short on the money and need to fulfil the climate change finance commitments set in the Paris Agreement, which leaves critical mitigation and adaptation requirements unfulfilled. Additionally, private investors still lack the resources, knowledge, and incentives necessary to operate more sustainably. Clearly, the discussion above contains a lot of assumptions. The amount of area available for renewable energy generation is anticipated to have a substantial impact on how quickly the decarbonization of renewable energy will progress. It is envisaged that new targets would assist a low-carbon economy and the eventual removal of environmental pollution from the environment in the future. The price is thought to have been affected thus far by the switch from coal to natural gas in the production of energy (Climate, 2020).

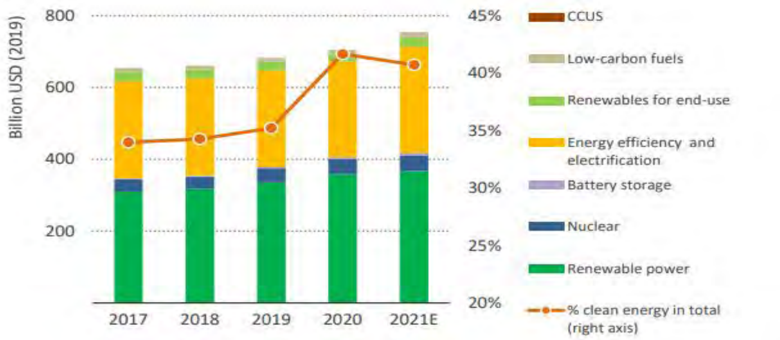
Figure 1.3 Investment in renewable end-use



(*Source: World Energy Investment, 2021)*

Additionally, increasing use of energy becomes crucial part of smooth growth that would address poverty. The main focus of the economies is towards development of economy irrespective of the environmental degradation. It is not possible to ignore the energy use as all the human and economic activities highly depend on energy sector. Therefore, the excess use of non-renewable like fossil fuels leads to decrease environmental quality and it's negatively effect on the development of green economy.

Figure 1.4 Global financial support for energy efficiency and renewable sources. 2017-2021



(Source: World Energy Investment, 2021)

The important factor that increases damage to the environment is carbon emissions. Using modern technologies to control greenhouse gas emissions or making agreements to reduce emissions are two ways that nations throughout the world are attempting to combat climate change (Pena et al. 2021; Serrano et al. 2021). The majority of nations still intend to attain net-zero carbon emissions by 2050–2070, but only the governments of 55% of the world's greenhouse gas emitters have stated explicit objectives for enhanced carbon emission reductions by 2030 (Chen et al. 2022; Wyns and Beagley 2021). In the interim, developing countries' energy systems continue to be strongly reliant on fossil fuels, and the extensive use of coal and oil in manufacturing and transportation leads to problems with climate change and environmental pollution (Su and Urban, 2021). Additionally, as the world's population and level of living expand, mass production and consumption have been facilitated by manufacturing automation, which has raised the amount of solid waste produced. The environment and general public's health are seriously endangered by the volume and complexity of waste that is increasing (Chioatto and Sospiro 2023; Kurniawan et al. 2022). "If serious steps are not taken the continues increase in environmental pollution could double by 2035" (Yu et al. 2022). However, In the conference of Paris Agreement, the target for temperature has set below 2°C (Dong et al., 2022). Global development continues to be threatened by the issue of climate change. Environmental experts are now debating how to navigate the intersection between carbon emissions and green finance (GFN). The ecological environment is now under more stress as a result of traditional economic development. There needs to be a better way to resolve the tension between ongoing economic growth and the scarcity of environmental resources as air, water, and soil pollution have gotten worse. Green financing has been hailed as a powerful tool for accomplishing structural change and green economic growth, and its use can accelerate green transformation. The financial operations and investments in green sectors are referred to as "green finance." The upgrading of the industrial structure can be accomplished by allocating funds through the government or financial institutions to help with the transition from a high-polluting or overcapacity sector to a low-polluting or environmental protection business. Green finance contributes to capital leveraging and resource reallocation during the process of modernising the industrial structure. Green finance employs de-capacity and deleveraging techniques to steer resources in order for high-polluting companies with excess production capacity to switch to green industries. In terms of resource allocation, the rational distribution of capital and credit ratios can lower the cost of financing green sectors, boost their market share and banks' transformation, and encourage the modernization of industrial structures (Chi, 2018: Wang et al.,2021). Barack Obama said at a speech at a climate change meeting in New York in

2014 that "the first generation to feel the impact of climate change and the last to be able to do anything about it." This notion is still valid almost ten years later as the nation struggles to cope with climate change's repercussions. Let's all take a moment to consider the financial and psychological costs incurred as a result of life-threatening fires, severe flooding, record-breaking heat waves, and other catastrophic climate catastrophes.

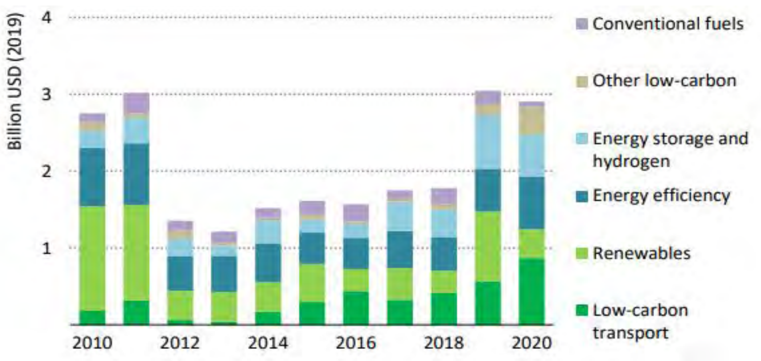
In the past five years, there has been a increasing interest in green financing as many companies, nations, and organisations view the green economy as essential to achieving the Paris Agreement objective of 1.5 °C global warming and below 2 °C. The resources to start meaningfully tackling the escalating effects of climate change were available in the years 2021 and 2022. The Inflation Reduction Act (IRA) of August 2022, which followed the Infrastructure Investment and Jobs Act (IIJA) of 2021, confirmed the change in US government energy policy by giving money for renewable energy and clean energy technology. Additionally, the Creating Helpful Incentives to Produce Semiconductors (CHIPS) Act is being promoted by Congress and will add about 280 billion dollars in new funds to support domestic semiconductor research and production. The opportunity to rewrite the rules for energy policy and investment is presented by the historic sum of money invested as a result of the IRA, IJA, and CHIPS Act, which is close to two trillion dollars. This opportunity has the potential to change industries, financial institutions, and communities. Today, however, the production of non-renewable energy is a environmental pollution demanding process, contributing about 2% of world environmental pollution. It is obvious that Researcher cannot advance toward a green economy by maintaining processes that produce greenhouse gases. Energy production must be done as cheaply and with the least amount of greenhouse gas emissions feasible, most likely necessitating the usage of renewable energy sources. What advantages each option has over the others in terms of competition, and when will prices become comparable to those of purchasing environmental pollution certificates? What market and regulatory structures are necessary for successful adoption? Researcher are currently debating these issues, which Researcher attempt to address in our viewpoint paper. Although there are no easy solutions, there are hints and cues Researcher can use to build a plausible story about how this might play out. Here, Researcher attempt to give the reader a knowledgeable and interdisciplinary perspective on what the green economy is and is not, as well as how it might change over the coming decades. The SDGs of the UN focused attention on the rising concern over environmental degradation and the high usage of natural resources, which opened a door for the introduction of contemporary ideas like sustainable growth. Does green finance encourage the purchase of renewable energy? Green finance is the investment in financial instruments linked to renewable energy and other environmentally friendly enterprises. Assets, securities, and money related to green business initiatives and renewable energy are referred to as being in the "green finance market." In recent years, it has become clear that the growth of new initiatives involving renewable technologies depends on a robust green finance sector (Shahzad et al., 2022). The financial sector previously disregarded the ecosystem, but it has started to take environmental concerns more seriously and has launched a number of financial products that are explicitly aimed at environmental conservation, such as green bonds and 255 products in list of OECD, which is the largest basket of green products. The following 10 primary categories make up OECD list (Li et al., 2022)

- Control of air pollution

- Environmentally friendly or resource-wiser technology and goods
- Products that are environmentally desirable based on features of end-use
- Controlling energy and heat equipment for “environmental monitoring, analysis, and assessment.”
- The maintenance of natural resources
- Reduction of noise pollution
- Renewable energy facility and “Solid waste management, hazardous waste management, and recycling systems”
- Soil and water treatment or cleanup
- Waste water management and treatment of potable water

Academics stress the importance of achieving sustainable economic growth and putting sustainable environmental policies in place. Few research have connected economics and ecology up until now. According to Wang and Zhi (2016), creating financing for solar energy can help achieve environmental sustainability.

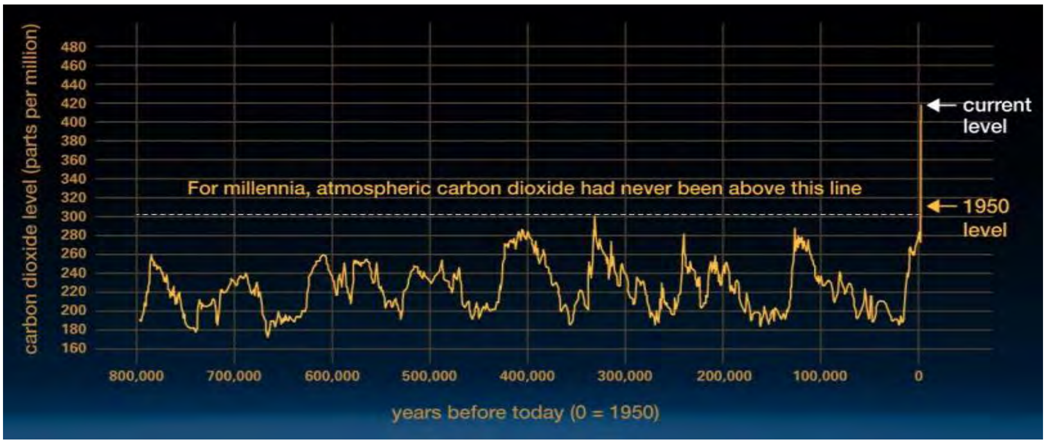
Figure 1.5 Investments in start-ups of sustainable energy technology on a global



(Source: World Energy Investment, 2021)

"In order to reduce environmental pollution, nations must take into account climate-friendly efforts, according to the United Nations Framework Convention on Climate Change." For the transition of economy into green economy, Green funding seems to be essential to advancing these activities (Shen et al., 2020). Regulatory authorities need to search for more eco-friendly financial resources in this view that are acceptable for a new stakeholder of environmental concerns and for the structure of institutions. This level of environmental pro-activeness will be necessary when new strategies for providing green financial resources take place in order to establish the constitutionality of the environment.

Figure 1.6 The relentless rise of carbon dioxide



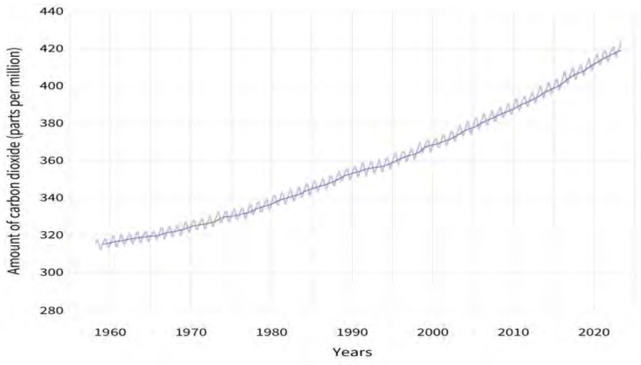
Note: This graph, based on the comparison of atmospheric samples contained in ice cores and more recent direct measurements, provides evidence that atmospheric environmental pollution has increased since the Industrial Revolution

(Source: Global climate change, 2021)

The Earth's atmosphere and environment thousands of years ago because to old air bubbles frozen in ice. They inform us that there is now more carbon dioxide (CO_2) in the atmosphere than there has ever been in the previous 400,000 years. carbon dioxide levels fluctuated between 200 and 280 parts per million (ppm) during mild interglacial times between 200 and 280 ppm during ice ages (see variations in the graph). For the first time in recorded history, CO_2 levels topped 400 ppm in 2013. This recent unrelenting increase in environmental pollution is strongly related to the burning of fossil fuels and is easily explained by the straightforward assumption that around 60% of emissions from burning fossil fuels remain in the atmosphere. Researcher are currently at the beginning of a new geologic epoch known as the "Anthropocene," in which the climate is considerably different from that of our ancestors. CO_2 emissions will continue to grow to levels of around 1500 ppm if fossil fuel combustion proceeds at the same rate it has been, depleting the reserves over the next few millennia. If this were the case, even tens of thousands of years in the future, the atmosphere would not return to pre-industrial levels. This graph highlights the fact that humans have a significant ability to alter the climate and planet, in addition to communicating the scientific measurements. The reason why the current warming trend is unique is that it has been definitely caused by human activity since the mid-1800s and is happening at a rate that has not been witnessed in many recent millennia. The atmospheric gases that have trapped more solar energy in the Earth system were undoubtedly created by human actions. The atmosphere, ocean, cryosphere, and biosphere have all undergone widespread and quick changes as a result of the additional energy. Joseph Fourier predicted that an Earth-sized planet at our distance from the Sun should be much colder in 1824, and hypothesised that something in the atmosphere must be acting as an insulating blanket. In 1856, Eunice Foote demonstrated that blanket, demonstrating that carbon dioxide and water vapour in Earth's atmosphere trap escaping infrared (heat) radiation. In the 1860s, physicist John Tyndall recognised Earth's natural greenhouse effect and hypothesised that slight changes in. Guy Callendar made the link between rising atmospheric carbon dioxide levels and global warming in 1938. Ice ages were connected to Earth's orbital properties by Milutin Milankovic in 1941. The Carbon Dioxide Theory of Climate Change was developed in 1956 by Gilbert Plass.

The physicist John Tyndall recognised the Earth's natural greenhouse effect in the 1860s and proposed that small changes in the composition of the atmosphere may cause climatic oscillations. The first prediction that variations in atmospheric carbon dioxide levels may significantly modify the surface temperature through the greenhouse effect was made in 1896 in a fundamental study by Swedish scientist Svante Arrhenius (Climate, 2023).

Figure 1.7 Atmospheric carbon dioxide



(Source: NOAA Global Monitoring Lab, 2023)

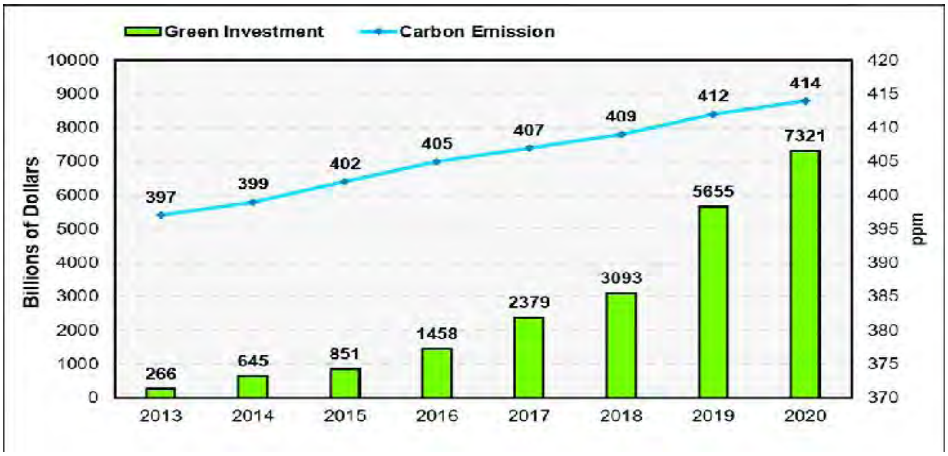
The observations made at Hawaii's Mauna Loa Observatory marked the start of the modern record of atmospheric carbon dioxide concentrations. In parts per million (ppm), this graph displays the station's monthly average carbon dioxide observations going back to 1958. Small peaks and valleys that make up the seasonal highs and lows are caused by the Northern Hemisphere vegetation's growth in the summer and decay in the winter. Human activity is what is behind the long-term trend of growing carbon dioxide levels. Carbon dioxide emissions into the atmosphere and organic pollutants in rivers both rise as a result of increased energy consumption (Lee et al. 2021; Zhuang et al., 2021). Financial development is a key to the economic growth of the country and is used as an instrument to minimize the risk of economic activity (King and Levine, 1993). One way for financial development is credit, which is widely characterized by development economists (Raifu and Aminu, 2019). Available literature elaborates that credit supply and access help in achieving and strengthening sustainable growth, technology adoption, and poverty reduction (Chandio et al., 2017).Well-developed financial markets that can aid in lowering energy consumption and carbon emissions by encouraging technical advancement in the industry supply money for the renewable energy sector (Zhou et al. 2022; Wu et al. 2021). Increased financial development results in better environmental quality. The financial industry has been a significant driver of societal development ever since the start of the industrial revolution. Making effective use of global savings is the major responsibility of the global financial sector. Financial development prompts several changes within a nation, such as, for instance, a decrease in financial risk and borrowing costs, increased transparency between lenders and borrowers, access to more financial capital and cross-border investment flows, and access to the newest energy-efficient products and cutting-edge technology, all of which have the potential to affect the demand for energy by increasing consumption. A person's quality of life can be improved with the right use of investment. However, as a result of the banking system's collapse, people have put their resources into initiatives that harm the environment and real estate bubbles, including those that worsen human-caused climate change. Prior until now, the financial industry neglected the ecosystem, allowing environmental problems like habitat loss and resource depletion, climate change, and pollution to develop or worsen. Finance is essential to understanding anthropogenics, or the effects of humans on the environment, yet little has been done to integrate environmental concerns into finance. Scholtens (2017), the nation's decision to permit and promote financial activities including increased foreign direct investment (FDI), increased banking activity, and expanded stock market activity is referred to as financial development, which is broadly defined. Financial development is crucial because it can improve a nation's financial system's economic performance, which in turn can impact economic activity and the need for energy. If it is discovered that financial development has an impact on energy demand, then this relationship may have an impact on energy policy and carbon emission reduction plans. Surprisingly little study has been done to date on the connection between economic growth and energy use. While Tamazian et al. (2009) demonstrate that financial growth reduces environmental pollution in the BRIC countries, Mielnik and Goldemberg (2002) establish a link between foreign direct investment and energy intensity in a sample of 20 emerging countries. In a study of 24 transition economies, Tamazian and Rao (2010) discovered that financial liberalisation could be detrimental to environmental quality if it is not carried out within a solid institutional framework. In a sample of 22 emerging economies, Sadorsky (2010) investigates the connection between financial development and energy demand. The relationship between financial development and energy demand hasn't been extensively studied in the literature as of yet. The goal of this essay is to examine how financial development affects the need for energy in economies. The financial industry has focused on green investments during the last few years, pushing sustainable growth (Falcone et al., 2018). Financial development has a conflicted impact on global energy consumption. In order to reduce pollution, it is also crucial to take green financing into account. Green finance has gotten a lot of attention in recent literature as a result of increased international efforts to mitigate climate change. The best approach to slow the rise of the global temperature is to support green finance efforts, as the entire world has learned. There is a higher demand for green finance as a result of the decreased energy use (Li et al., 2021). If more people invest in green finance programmes, there will be less pollution in the environment. The long-term needs of a decent and sustainable community can be satisfied by a worldwide economic system that develops, standards, and manages investment resources. The only objective of all financial instruments is to facilitate a green financial shift to reduce the rising environmental pollution. These financial instruments are allocated for programmes and involvements for renewable development, agronomic goods, and strategies. Lowering risk expectations and managing environmental issues are two of green finance's main objectives. To ensure that green initiatives are given precedence over investments that support unsustainable growth patterns, it is crucial to increase the accessibility and affordability of green finance. Green finance, which incorporates many of the requirements for sustainable growth defined in the Sustainable Development Goals (SDGs) of the United Nations, facilitates long-term investment and openness to environmental objectives (Jinru et al., 2021). Exciting accomplishments by international organisations and national governments, reflecting an increased commitment to environmental sustainability, include the approval of the United Nations Sustainable Development Goals and the Paris Climate Agreement. A green environment can be attained with the use of green financial instruments. The process led to the creation of financial instruments by financial intermediaries and markets, including green bonds, green home mortgages, green loans for commercial buildings, environmental home equity programs, "go green" auto loans, small business administration expedited loans, and climate credit cards. Additionally, Australia started its first environmental deposit initiative, which consists of medium- to long-term financing instruments that directly support sustainable development and climate-related projects in addition to financing environmentally beneficial enterprises and economic activities (NATF, 2007). Green finance is the nexus of environmentally conscious behaviour and the financial and corporate worlds nevertheless, few research have connected finance and ecology (Scholtens, 2017). Environmental finance/sustainable finance, according to Li and Jia (2017), is the most successful strategy for halting environmental damage. Researcher are therefore driven to investigate how dynamic green finance influences countries that support green financing's environmental pollution (Meo et al.,2022).

One of the major dangers the planet is currently facing is global warming. The Sustainable Development Goals (SDGs) of the United Nations (UN) focused attention on the rising concern over environmental pollution and the depletion of natural resources, which opened the door for the introduction of contemporary ideas like sustainable growth. The financial sector previously disregarded the ecosystem, but it has started to take environmental concerns more seriously and has launched a number of financial products that are explicitly aimed at environmental conservation, such as green bonds (Meo et al.,2022). Global environmental degradation has been exacerbated by overuse and abuse of natural resources (Orsatti et al., 2020). A strong and urgent need to use green finance as an institutional driver to mitigate environmental externalities is created by this severe environmental degradation. Because its fundamental goal is the trade-off between the expanding versus the greening economy, appropriate green finance can lower negative environmental footprints and enhance environmental quality (Brandi et al., 2020). Green finance is a topic that needs more clarification, and experts have not yet agreed on how to define it.

Green finance is the "financing of investments that provide environmental benefits," according to Zhang et al., (2019). Green finance is described as "financing of investments that provide environmental benefits in the broader context of environmentally sustainable development" by the G20 Green Finance Study Group (2016). Among these environmental advantages include, for instance, decreases in greenhouse gas (GHG) emissions, greater energy efficiency while using already-existing natural resources, as well as mitigation and adaption to climate change and their associated advantages (Green finance report, 2016). A green central bank, fintech, community-based green funds, green financial bonds, green banks, carbon market tools, other new financial instruments and new policies, fiscal policy, and expanding the financing of investments that provide environmental benefits are all necessary for achieving the sustainable development goals (Duchêne, 2020; Sachs et al., 2019).

At the start of the Industrial Revolution, Western industrialised nations used the momentum to aggressively develop their economies, which resulted in significant changes to both production and people's way of life. However, the natural ecology of the Earth, upon which humanity depends, is in grave danger as a result of the rapid rise in the number of environmental pollution sources brought on by the overzealous pursuit of commercial interests in various countries. Local environmental degradation has become a global issue due to excessive energy use, the greenhouse effect, and other climatic issues. The tension between ecological balance and the exploitation of natural resources has grown more significant as pressures on the environment and energy security of various countries continue to rise (Wang et al., 2021). The ADB is committed to reducing climate change in many sectors, with a primary focus on the core areas of "clean energy, sustainable transport and urban development, land use and forest carbon sequestration, sustainable climate development and strengthening policies, governance, and related agencies" in order to mitigate environmental degradation (ADB, 2020). The ADB intends to use green climate funds (GCF) for adaptation projects (e.g., enhancing livelihoods, health and well-being, as well as food and water security, infrastructure and the built environment, ecosystems and ecosystem services, and climate information), mitigation projects in the public and private sectors (e.g., transportation, cities, industry and appliances, land use/forestry, and institutional and regulatory systems), and (ADB, 2020). Governments and international organisations are working to ensure sustainable development by creating policy-based environmental protection funds, creating pertinent regulations, and introducing pertinent laws and policies to support green finance development.

Figure 1.8 Global green investment and carbon emissions



Note: Global carbon emissions and green investment. The amount of green investment is shown as a bar chart (in billions of dollars). The carbon emissions into the atmosphere are shown as a line graph (in parts per million).

(Source: Bloomberg, 2022)

In order to support sustainable financial development, green finance offers financing for all economic sectors and assets that incorporate environmental, social, and governmental factors into investment decisions. Reporting on the investment value chain is increasingly using social, ecological, and governance information. As the practise moves from the niche to the mainstream, investors start to pose challenging concerns about how environmental, social, and governance accomplishments are evaluated, managed, and reported. Evaluations of the risks related to environmental, social, and governmental governance elements are significant parts of an insurer's overall risk assessment, as are evaluations of physical risk, transfer risk, and liability risk. Challenges in government, society, and the environment have an impact on the creditworthiness of banks. In their risk and pricing analyses, banks will also take into account green loans and environmental effects. Institutional investors can better comprehend the risks and rewards of their investments by choosing a portfolio that takes environmental, social, and governance concerns into account (Taghizadeh-Hesary et al., 2022). The European Commission defined CSR in 2001 (EC 2021) as "a concept whereby enterprises integrate social and environmental issues into their business operations and interact voluntarily with their stakeholders." In addition, the GEF is the largest independent donor of projects aimed at enhancing the environment worldwide. Over 2700 projects in 165 poor nations have received grants totaling $10.5 billion from the GEF, which has also used US$51 billion in eco financing. (ADB, 2020). The ADB and the GEF have been collaborating closely since the late 1990s, and the ADB is one of ten organisations that has received funding directly from the GEF since 2002. The ADB's collaboration with the GEF is founded on the understanding that there is a crucial connection between the environment and sustainable development and that the long-term growth of nations, especially those in the Asia-Pacific region, depends on the wise management of natural resources, biodiversity, and ecosystems (ADB, 2020). Seven difficult global environmental issues that relate to GEF priority areas have been addressed by GEF initiatives and programs, one of which is climate change. (mitigation and adaptation). The ADB pledged in 2015 to increase climate finance from its existing funds to $6 billion yearly by 2020. Before the landmark United Nations worldwide climate change summit conducted in Paris, this was the organisation's first announcement (ADB, 2020). This lofty objective was predicated on the acceptance of a project that included climate-related factors and associated financing. The ADB accomplished this in 2019 by using its resources to provide over $6.37 billion in climate financing and by securing a total of $74.9 million in outside funding (Khan et al 2022). By 2030, greenhouse gas emissions must be reduced by 40%; this can only be done with the help of finance and technology (United Nations Climate Change Conference, 2021). The significance of green finance in solving climate change concerns is highlighted in this context by combining funding from public, private, and alternative sources and assisting with mitigation and adaptation measures. In particular, green bonds stand out as a much more practical choice than any other type of finance instrument for addressing climate change by allocating money to green initiatives.

Figure 1.9 Global green finance

Note: According to the data, between 2012 and 2021, green bonds made up 93.1% of all green financing globally. In 2021, $511.5 billion in green bonds were issued globally, up from $2.3 billion in 2012.

(Source: Reuters, 2022)

According to Muganyi et al. (2021), green financing is an environmentally conscious investment approach. As a result, GFN fills the financial vacuum left by insufficient government spending by allowing private investors to fund environmental initiatives.

Figure 1.10 Green IPOs

Note: According to the data, there were 401 publicly traded businesses engaged in green operations in 2012 and 669 in 2021.

(Source: Reuters, 2022)

Environmental risks have exacerbated issues with global warming that is caused by environmental pollution (Mohsin et al., 2021; Mohanty and Sethi, 2022). Despite the fact that these human activities also contribute significantly to environmental pollution (EVP). The ecology and climate are being burdened more and more by the damaging gas emissions as economy grow and the fast depletion of NRR (Razaq et al., 2021). Emerging serious ecological issues and energy crises pose a threat to human society's ability to evolve sustainably (Wu et al., 2021). Countries have not made considerable economic progress despite having a wealth of natural resources. Therefore, policymakers, governments, and researchers are becoming concerned about urbanization (URB) activities because of the environmental problems they pose. This study examine how urbanization, financial development, green finance, renewable energy use, foreign direct investment, economic growth and natural resource rent interact with energy efficiency and environmental pollution.

1.2 Problem Identification and Problem Statement

Urbanization and deforestation has a serious impact on environment. Countries need to switch towards non-fossils fuels, which include in this term renewable energy to increase the energy efficiency, that's what Researcher are striving for. Energy plays a vital part in economic growth because it is a necessary input for economic activity (Yu and He 2020). In this context, some countries' energy consumption has rapidly increased as well (Wang et al. 2015). Increased energy consumption and carbon emission restrictions are the two main obstacles in the global energy transformation stage (Yu et al. 2020). The same problem, namely how to meet the rising energy demand while simultaneously reducing carbon emissions, was covered in British Petroleum's (BP 2019) World Energy Outlook study. According to the International Energy Agency, the largest energy consumers are the residential, transportation, and industrial sectors. Energy efficiency is therefore a major concern, and advancements in it have the potential to drastically reduce energy use and environmental pollution. Several nations have also passed legislation to improve energy efficiency (Locmelis et al. 2020). In order to meet the Paris Agreement's 1.5 celcius limit for global temperature, carbon emissions must be minimized. The investment needed to achieve the climate goal are huge but green finance has the power but also shares responsibility on other economic factors to make that happen.

1.3 Rationale of Study

The importance of this study rests in its thorough examination of how green financing, economic expansion, energy efficiency, along with environmental sustainability interact. Understanding the means to achieve environmentally friendly development is essential as the world community struggles to address the urgent issues of climate change and degradation of the environment.

First, the study incorporates the moderating effects of financial development with the mediator (renewable energy use) in the analysis of the effects of FDI, GFN, EG, NRR, IT, and URB on environmental degradation and energy intensity. Second, whereas most studies have included financial development as a stimulant factor to several purposes. In this model, financial development included as a conditional factor. Third, There is a need to address the variable that is omitted from the previous literature. Several studies have studied on the macro factors of economy that contributes in the growth of economy. Those macro variables are FDI, urbanization, renewable energy use, human capital, trade openness, population size and globalization, etc. Among these variables, this study incorporates some of them to check the impact of these variables on environmental quality. By using a moderated mediation technique, this study was able to investigate whether a sound financial system can manage energy intensity or lower pollution by looking at the direct an direct effects of REU, GFN, EG, NRR, IT, and URB on environmental pollution and energy efficiency.

1.4 Significance

The findings of this study can help decision-makers in the public and private sectors understand how crucial it is to incorporate sustainable financial practises into their plans and activities. Policymakers can create tailored measures to encourage eco-friendly investments along with projects by acknowledging the part that green finance plays in affecting environmental results. Similar to how businesses as well as financial institutions might use these discoveries to create sustainable financing strategies that support broader economic growth and environmental objectives.

Additionally, this study offers a useful foundation for further research in the areas of environmental economics and sustainable finance. To gain a greater understanding of the topic, researchers might build on these findings to investigate additional variables that can affect the connection among green finance with environmental sustainability.

In conclusion, the importance of this study rests in its potential to influence financial decision-making, inform policy, and motivate additional investigation in the quest for a more robust and sustainable global economy. It adds to the greater conversation about creating a greener and more sustainable society by illuminating the complex relationships among finance, economic growth, energy efficiency, along with the environment.

1.5 Research Objectives

The shift to low-carbon energy has become more dependent on the financial industry (Chenet et al., 2019). The total amount of investment needed globally has been estimated $100 billion for fulfilling the SDG stated by UN and the goals to overcome climate challenges outlined in the "Paris Climate Agreement." But the rate and scope of advancement are not encouraging. According to (IRENA, 2020), the world will need to invest $2 trillion in green projects between 2021 and 2023. The goals to study these variable are following:

The objective of study is to investigate the direct impact of green finance and other economic variables on environmental polution and energy efficiency.

- The second objective of study is to investigate the indirect impact of green finance and other economic variables on environmental polution and energy efficiency through the mediation of renewable energy use.
- The third objective of study is to investigate the first stage mediated moderation of Financial development between green finance and other economic variables on renewable energy use.
- The fourth objective of study is to investigate the second stage mediated moderation of Financial development between renewable energy use on environmental polution and energy efficiency.

Investments in energy systems are expected to be needed between US$1.6 and US$3.8 trillion annually between 2020 and 2050 in order to maintain efficient systems and prevent adverse climatic effects. These statistical findings demonstrate the importance of energy efficiency (EE) and the shift to low-carbon energy sources, which is an urgent necessity (Schumacher et al., 2020). An estimated annual investment required across all societal sectors to realize the SDGs ranges from $5 trillion to $7 trillion. For fulfill this purpose, Paris Agreement calls for cost and benefit analysis for ongoing funding, followed by a lot more international investment. The fund related to green climate, which is important for taking initiatives in financing green, will aid green initiatives to lower 1.4 billion tonnes of worldwide emissions of GHG. The Spanish government has promised to increase its financial support for the Green Climate Fund in November 2021 in order to help developing nations to cope with climate change. Second, green financing gives greater weight to societal advantages for the living environment. In the end, it accomplishes sustainable social development by concentrating on the healthy and balanced development of both economy and the environment.

1.6 Research Gap

Through this study, Researcher fill a number of gaps in the literature that may be summed up as follows: first, there are conflicting findings regarding how these variables affect pollution and energy intensity. This flaw can be attributed to the sample selection as well as the methodology used in the modelling that linked the GFN, REU, URB, EG, IT, and NRR, with EE and environmental pollution. The majority of studies haven't tried to dig into the conditional relationships between GFN, REU, URB, EG, IT, and NRR and environmental pollution and energy intensity in this regard. The indirect impacts of GFN, REU, URB, EG, IT, and NRR on environmental degradation and EE have been the subject of recent research, but these effects have not yet been thoroughly studied. Second, there haven't been many studies that examine how financial development affects FDI, EE, and environmental pollution as well as green economic aspects. Prior research ignored the impacts of FD on FDI and focused only on the moderating effects of financial development between these factors and pollution (Husam Rjoub et al., 2021). Nonetheless, it looked at how foreign direct investment may help Sub-Saharan African economies' financial inclusion, financial development, and sustainable development (Bosede Ngozi Adeleye at al,2020). Additionally, the role of financial development was mostly examined in terms of its propensity to encourage FDI (Chien-Chiang Lee et al., 2019; MA Islam, 2020), rather than as a moderating factor for the effects of these green economic factors on FDI, EVP and EE.

1.7 Research Questions

This study adds to a number of previously published literary works. In this analysis, the following research issues were prioritized:

RQ1 Do GFN, REU and other independent variables have a direct relationship with environmental pollution and energy efficiency?

RQ2 Do GFN and other independent variables have a indirect relationship with environmental pollution and energy efficiency through the mediation of REU?

RQ3 How financial development as a moderator influence on the relationship between green finance and other economic variables on REU?

RQ4 How financial development as a moderator influence on the relationship between REU with environmental pollution and energy efficiency

1.8 Initial Findings

After determining the direct and indirect correlations between the variables, this study used the difference GMM technique to look at the moderation effect. The results show that all other variables, with the exception of EG, exhibit a direct and significant correlation with environmental pollution. REU serves as a mediator between all the factors. The majority of the existing research makes the assumption that the main cause of rising environmental pollution is the expansion of energy consumption, which is mostly produced from non-renewable sources. Therefore, the purpose of this study is to find out how renewable energy might reduce environmental pollution and enhanced energy efficiency by looking at the effects of different variables, such as NRR, IT, EG, URB, FDI, and GFN

The next section will follow in two steps from here. Researcher will first look at how GFN, FDI, URB, EG, IT, and NRR directly affect EVP. Furthermore, Researcher will investigate if financial development influences REU, subsequently impacting environmental pollution and energy efficiency, by moderating the relationship between GFN, IT, FDI, URB, EG, and NRR. According to the results of the correlation analysis involving environmental pollution, NRR demonstrates a positive and substantial association with environmental pollution, suggesting that rising NRR consumption results in larger environmental pollution. The association between GFN and environmental pollution, on the other hand, exhibits a negative correlation even if it is not statistically significant, suggesting that a rise in GFN may lead to a fall in environmental pollution. EG and environmental pollution have a positive and significant association, which suggests that rising EG results in rising environmental pollution. Additionally, there is a substantial and positive association between URB and environmental pollution, suggesting that rising URB corresponds to rising environmental pollution. REU, FDI, and FD, on the other hand, all exhibit adverse and substantial relationships with environmental pollution, indicating that a rise in these variables results in a fall in environmental pollution. Both IT-IMP and IT-EXP have substantial negative correlations with environmental pollution, showing that rising levels of either variable causes a fall in environmental pollution. Regarding the relationship between numerous variables and energy efficiency, the investigation yields important findings. The use of NRR increases energy efficiency, according to a positive and significant link between the two variables. Similar to energy efficiency, GFN shows a significant and positive link, showing that rising GFN leads to improved energy efficiency. As a result, it appears that an increase in EG results in a loss in energy efficiency. In contrast, EG exhibits a negative and substantial link with energy efficiency. URB follows the same pattern, with an increase in URB leading to a decrease in energy efficiency. It is clear from the negative and substantial correlations between REU, IT-IMP, IT-EXP, FDI, and FD that an increase in these variables results in lower energy efficiency.

In conclusion, this study uses the difference GMM approach to look at moderation effect, pinpoints direct correlations between variables, and investigates how using renewable energy and numerous economic factors affects environmental pollution and energy efficiency. When creating policies to reduce environmental pollution and promote sustainable energy practices, these insights add to the body of existing knowledge and offer policymakers and stakeholders useful information.

1.9 Overview of Chapters

The structure of our study is as follows: first, Researcher gave a theoretical background, objectives, problem statement, research gap and questions. Second, literature has focused particularly on the variables, connections between the variables. Third, Researcher described the research methodology, framework, empirical model and analysis. Finally, Researcher presented the findings together with the discussion and conclusions.

CHAPTER TWO

LITERATURE REVIEW

The complex interactions between many independent variables and their effects on the dependent variables, environmental pollution, and energy efficiency, have come to more and more attention in recent years. As a new idea, "green finance" refers to financial strategies for supporting ecologically friendly projects and programmes. An objective that is frequently pursued, economic expansion, has effects on energy efficiency as well as environmental preservation. Urbanisation, which is fuel by population increase and migration, brings opportunities and problems for energy consumption and sustainable development. Foreign direct investment (FDI) has a big impact on how resources are allocated, how economic activities are conducted, and how the environment turns out. Natural resource rent, which results from the exploitation and use of natural resources, affects both economic expansion and environmental deterioration. Globalization-driven international trade has an impact on energy efficiency, emissions, and resource use. For effective policies and strategies to achieve sustainable development goals, it is essential to comprehend the complex interactions between these independent variables—green finance, economic growth, urbanization, FDI, natural resource rent, and international trade—as well as their effects on the dependent variables, environmental pollution and energy efficiency. Additionally, this chapter will look at the moderating impacts of financial development and the mediating effects of renewable energy consumption, both of which are important in shaping the dynamics between these variables. By reviewing the body of existing information, identifying research gaps, and establishing the basis for the empirical analysis done in this MPhil dissertation, this chapter seeks to shed light on the current understanding of these linkages.

2.1 Economic factors

2.1.1 Environmental Pollution

Global warming poses a serious threat to peoples' health and well-being on a global scale. The impact of human activities on the rise in atmospheric CO_2 concentration and the state of the world's climate has been debated since more than a century ago. In 1861, John Tyndall hypothesized that CO_2 may efficiently absorb heat (Tyndal, 1861). Other early studies Arrhenius, (1896); Bolin et al., (1959), improved our knowledge of the connection between atmospheric environmental pollution concentration and global temperature by providing accurate background data on atmospheric environmental pollution concentration, which made it easier to document subsequent environmental pollution concentration increases. According to Sundquist, (1987); Barnola et al., (1987), global temperature and atmospheric environmental pollution content were found to be correlated by historical ice core data. The GWP of other trace gases (such N_2O, CH_4, and chlorofluorocarbons) started to be understood in the 1970s. The Intergovernmental Panel on Climate Change (IPCC) was established in the 1980s after the anthropogenic contribution to global warming attained sufficient credibility to stoke international political activity (J. Houghton et al., 2001). This was followed by a plethora of additional research. The effect of greenhouse gases produced by humans on global climate change has been verified by recent studies (Climate Change, 2007; J. T. Houghton et al., 2001). According to estimates, the atmosphere's pre-industrial CO_2 content was between 290 and 295 ppm. The CO_2 levels exceeded 370 ppm at Scripps Institution of Oceanography monitoring locations in 2004 (Keeling & Whorf, 2004) after reaching 350 ppm by 1990 (Wood et al 1990). By the end of the twenty-first century, CO_2 levels are expected to hit 500 ppm. According to the IPCC (IPCC, 1996), atmospheric concentrations of CH_4 and N_2O had increased by 145% and 15%, respectively, from pre-industrial times by 1992. Livestock also has a role in the rise in GHG emissions. There is broad scientific consensus that human activities contribute to global climate change even though the dynamics of climate interconnections are not fully understood. According to Houghton et al., (2001), no matter their level of development, economies have concentrated on controlling GHG emissions since the UN's goals for the Millennium Development Goals emerged. They must control their emissions since industrialized nations and nations with an industrial focus have an impact on the environment. However, prominent organizations and UN member states have noticed a more concentrated and targeted approach to environmental conservation and sanitization since the launch of the SDGs (Schäfer et al., 2015). Skrúcaný et al., (2019) examined various policy implications and the effects they have on European countries. They proved that, irrespective of the state's degree of development, cautious sustainability necessitates policies.

Massive emissions caused by human activity, particularly the burning of fossil fuels, are now being recognized as a major contributor to global warming and a potential trigger for a global climate emergency. The use of fossil fuels has boosted global warming, and recent years have seen a sharp rise in environmental pollution (Perera. F, 2018: Xu. T, 2018). The economic development of emerging nations suggests that they will produce the majority of future emissions worldwide (Sandu, S et al. 2019). It is generally accepted that environmental pollution from the burning of fossil fuels are the main factor contributing to human-induced climate change (Rehman et al., 2021). Researcher examine what the outcomes would have been if the inquiry had been conducted using different modelling techniques and countries.

2.1.2 Energy Efficiency

Energy efficiency provides numerous benefits for the environment. It reduces greenhouse gas emissions significantly, like direct emissions from the consumption or combustion of fossil fuels and additional emissions from the production of electricity. Energy efficiency is one of among the most important methods to meet the growing energy demand while consuming less energy. More recently, Mavi and Mavi, (2019), conducted analysis between the relationship of energy efficiency and environment. According to the report, United States, Ireland, and Switzerland the have made considerable advancements in their countries' energy and environmental efficiency during the past ten years. Lv et al., (2019), investigated how income and urbanization affected energy intensity in 224 Chinese cities. Using annual data from 2005 to 2016, the study used geographic methodologies for analysis. According to the empirical results, urbanization in China has negatively impact on the energy intensity whereas income shows adverse effect. Kose et al., (2020), looked at the role of total energy consumption and research & development for the case of 16 European economies. The empirical findings of PMG supported the claim that all types of energy and R&D positively influence economic growth in European economies. The effect of technology on greenhouse gas emissions is embodied by energy efficiency. As nations develop, they acquire more resources that enable the production of energy-efficient products (Mirza, F. M et al., 2022). Recent research conducted by Hossain et al., (2022) and Mirza et al., (2022) have demonstrated that conserving energy reduces the environmental impact of greenhouse emissions. In comparison to sources of energy derived from fossil fuels, renewable energy serves an essential role in achieving carbon neutrality. This study investigates what the outcomes would have been if the inquiry had been conducted using different modelling techniques and countries.

2.1.3 Green Finance

Green funding may enhance environmental quality by encouraging innovative thinking among companies. Under the direction of suitable green finance legislation, the flow of financial resources to eco-friendly, low-carbon firms increases. According to numerous studies, green finance legislation will improve enterprises' capacity to innovate in the green industry. Green innovation will loosen the financial constraints on businesses, allowing additional financial resources to enter the field. According to Zeppini et al. (2011), green knowledge is understood to be complex information that calls for a variety of organizational capabilities and resources, including green financing. According to Azhgaliyeva et al. (2018), private investments in the environment reduce carbon dioxide and turn an economy into green. Several examples show how the use of green money has some impacts. First, green finance gives funding to companies that support green innovation, helping them acquire eco-friendly equipment, implement cutting-edge green technology and train their staff accordingly. Second, by providing green financing for diverse initiatives, stakeholders (organizations, governments, and regulators) can spend money on R&D for environmental challenges while lowering the risk associated with green policies. Last but not least, green policies are more expensive than conventional methods (Kveton et al. 2018), but green financing can cover these costs without encountering significant financial difficulties. According to Glomsrd et al. (2018), green finance would boost the usage of renewable electricity by up to 46% globally and reduce coal consumption by 2.5 percent by 2030. Various sustainable development goals can be attained by encouraging private engagement in green finance and investment, which is directly and indirectly related to green finance (Taghizadeh-Hesary et al., 2019). Green financing encompasses a wider variety of activities, such as recycling, clean water, biodiversity preservation, pollution control, protecting environment and proactive measures. It is not just about renewable energy and efficiency (Krushelnytska, 2019). Some studies, nevertheless, concentrate on how the effects of green financing influence green economy. According to Dikau et al. (2018) and Sachs et al. (2019), green investments have a favorable effect on the objectives of sustainable development. The study found that from $5.2 billion in 2012, global borrowing through the issuance of green bonds and loans, as well as equity finance through initial public offerings targeted at green projects, increased to $540.6 billion in 2021. The increase in issuance highlights the increased effort being made by organizations and governments to reduce carbon emissions and meet climate targets (Global green finance, 2022). Surprisingly little research has been done on the connection between green money and environmental quality. A few studies, nevertheless, concentrate on how green finance affects the green economy and environment quality.

Green finance eases energy restrictions as well as positively affects environmental pollution and increases the growth of economy (Shen et al. 2020). Countries all over the world have invested money in green initiatives to introduce, invent, and employ environmentally friendly technology to safeguard the environment and optimize environmental performance in order to guarantee green economic growth. Green financing works for the betterment of economy. It encourages the green policies, safeguards natural resources and protect the environment by reducing pollution (Orsatti et al., 2020: Khan et al., 2022). Therefore, the study examines what the outcomes would have been if the inquiry had been conducted using different modelling techniques and countries.

In order to foster economic growth, banks serve as a mediator in the collection and distribution of idling money among the community (Andreeva et al., 2018). The 'green' aspect of green finance necessitates that financial resources be allocated to corporate governance, social inclusion, renewable energy, green building, climate change, and environmental protection across all economic sectors (Urban & Wójcik, 2019). Green finance is becoming more significant in the banking industry as a result of the need to protect banks and society from unexpected future economic issues brought on by unexpected global financial incidents such as the threat of climate change, social rest, and corporate scandals (Ziolo et al., 2019). The distribution of environmentally friendly products has also become part of the traditional banking paradigm (Dikau & Volz, 2021).

Financial regulators and major participants in the banking industry from all over the world vowed to support the promotion of environmentally friendly financial products at the 2017 "One Planet Summit" in Paris (J. Y. Kim, 2017). According to (Urban & Wójcik, 2019; D. Zhang et al., 2019), the World Bank plans to stop lending money to organizations and nations that don't prioritize environmental protection. A number of financial institutions, including Société Générale, Hong Kong-Shanghai Banking Corporation (HSBC), Deutsche Bank, BNP Paribas, and Credit Agricole, have declared a change in their strategic corporate policy in favor of the adoption of eco-friendly products. They intend to stop supporting people and organizations whose actions have a negative impact on the environment (Sanchez-Roger et al., 2018). To direct sustainable financial transactions in the banking sector, several central banks, like the People's Bank of China, have created and implemented laws (L. He et al., 2019a). It's interesting to note that despite the importance of these agreements, a sizable percentage of banks across the globe haven't demonstrated a readiness to create green financing financial products. Because of this, green financing has not been adopted in a sizable number of international regions. It faces a number of challenges on a global scale, including an absence of consistent laws and regulations, significant risks, a limited scope and size, and other challenges.

Recent studies have looked at the role green finance plays in environmental protection. In order to improve environmental performance, green finance may encourage financial assistance, resource allocation, and technical advancement. Capital assistance's impact serves as an example of how green finance can be used to enhance social and environmental performance. While opposing excessive pollution and fostering industry, green financing seeks to reduce energy use and environmental pollution. According to a study by Van Veelen, (2021), the addition of green credit terms to financing in the People's Republic of China affects the costs of corporate financing. Their empirical results show that green credit lowers the cost of financing for eco-friendly enterprises while raising it for high-emission and high-pollution businesses. Srivastava et al., (2022), looks into how the development of green finance has impacted the environment and its macro-mechanistic role.

2.1.4 Urbanization

Urbanization is the term used to describe the shift of population from rural to urban areas. In order to determine the long-term correlation between urbanization, economic growth, and environmental pollution, Al-Mulali, Sab, and Fereidouni (2012) applied FMOLS in seven regions of the world (South Asia, East Asia and Pacific, Middle East and North Africa, Latin America and Caribbean, East Europe and Central Asia, Western Europe, and sub-Saharan Africa). Their findings demonstrated that there are significant long-term positive relationships between the variables in 84% of the nations. According to Arouri, Youssef, Nguyen-Viet, and Soucat (2014), it is typically associated with industrialization and economic progress in developing countries, as people relocate from rural areas to urban ones in search of employment and better possibilities. Even though it offers prospects for a more contemporary lifestyle, urbanization is intimately linked to environmental deterioration. In high-income nations, air pollution peaked in the middle of the 20th century, working against the progress of urbanization. Global air quality will change as a result of how low- and middle-income countries evolve, particularly in terms of their knowledge of the trade-off between urbanization and air quality (Han et al, 2014). Therefore, analyzing and summarizing the many processes of trade-off between urbanization and air quality would offer more information. Differentiation in the stage of urbanization and its associated air quality has been brought about by variations in the development of economy, technology levels and location (Gollin et al., 2016). Urbanization has been determined to have a major impact on environmental pollution by many researchers (Destek et al., 2016; Sbia et al., 2014 & Ozturk, 2017; Wang et al., 2017). According to Franco, Mandla, and Rao's (2017) research, an increase in the number of urban dwellers and industrialization has a major effect on energy demand, which in turn results in environmental deterioration. According to the Wang et al. (2019), the study's findings supported an “inverted U-shaped relationship between urbanization and environmental pollution.” It indicates that rapid urbanization growth helps to reduce environmental pollution secretion. Although the results are significant to the academic community, the study was only conducted for a short period of time from 2005 to 2015. Because the results would change if more countries or places or historical periods were included, the conclusions cannot be generalized to other countries around the world. Between 1991 and 2019, Khan and Su, (2021), investigated how urbanization affected environmental pollution in newly industrialized countries. The study looked at the optimum amount of urbanization at which newly industrialized countries could reduce their environmental pollution. The results showed that when urbanization is below the threshold value, it has a favorable effect. When urbanization surpasses a certain point, however, it impacts environmental pollution negatively. Although the academic community places a high value on these findings, caution should be exercised in interpreting them because not all industrialized nations were included in this study and different modeling techniques still not studied. Researcher examine what the outcomes would have been if the inquiry had been conducted using different modelling techniques and countries.

2.1.5 International Trade

It is crucial to recognize the role that trade plays in promoting environmentally friendly technologies. “Trade is essential for greening the energy market since it has the capacity to transmit clean energy innovations. Due to the effective use of resources and the advantages of economies of scale, trade openness is desirable.” Additionally, import and export both have the potential to provide superior inputs for the use of green energy. In essence, trade openness will support renewable energy even more. First, it is frequently stated that the level of trade flows or trade openness is a direct result of environmental degradation (measured by the degree of CO_2 as a proxy) (Ertugrul et al., 2016; Iorember et al., 2021; Ike et al., 2020; Usman, et al., 2020; Yu et al., 2019). The fundamental argument is that there is a close connection effect because trade flows necessitate increasing a nation's economic capacity, which in turn produces externalities in the form of environmental damage. Therefore, except in cases where these inclinations are properly reduced or in which the expansion is fueled by clean energy, a situation known as "green growth," growth is not environmentally good. Because of how interwoven the global economy is, it is possible to link the consumption of traded goods in one nation to GHG emissions in another. Therefore, it has a significant role in climate change and growth of economy by utilizing the sources related to green energy. The study will examine what outcomes would have been if the inquiry had been conducted using different modelling techniques and countries.

2.1.6 Natural Resources Rent

The finding that those nations have abundant NRR—like oil and gas—generally have weak economies. The literature mostly demonstrates that growth of economy is the source of existence for natural resources, even though these relationships are not entirely conclusive. Recent research has centred on issues including low institutional quality, corruption, and economic mismanagement, which worsen the natural resource curse. As a result of the government's tendency to downplay the significance of ongoing investments in both public utilities and human development when it believes that the public finances are strong, residents may lack motivation to invest in their human capital (Gylfason et al., 1999; Gylfason, 2001). Mehlum et al., (2006), noted that "natural resource-rich countries constitute both growth losers and growth winners, with the fundamental difference between the success cases and the failure cases being in the quality of institutions. Iimi, (2007) uses resource rents as an illustration to support his claim that economic mismanagement is a significant component because these rents can provide policymakers a false sense of financial security. In addition, there is evidence that sudden increases in resource income windfalls may restrict democratic accountability in the government (Tsui, 2011). Even at the macroeconomic level, the cumulative evidence of the effect of institutions on the resource curse is still inconclusive. Although the existence of resource rents does have the potential to encourage corruption, the rent does not in and of itself bring about the curse. Other recent empirical research either disproves the existence of a resource curse or indicates that it has a positive impact on GDP growth (Brunnschweiler and Bulte, 2008; Cavalcanti et al., 2011; James, 2015). In a similar vein, Badeeb et al., (2016), demonstrate that the oil curse can also have an impact on private investment. The primary sign of the resource curse would then be the development of inefficient enterprises in the domestic sector, whether they were SOEs or POEs, due to lower levels of human and physical capital. it is claimed in research of Ang et al. (2018), conflicting forces affects on its development even for quantifiable components like financial institutions. A more intriguing explanation for economic growth was provided by González-Val and Pueyo, (2019), who cited factors such as a growing population, a decline in the cost of innovation, and in particular, a lack of regional disparities in the exploitation and use of natural resources. However, Vasilyeva and Libman, (2020), identified the importance of political regime in the positive relationship of natural resources and economic growth in the Russian Federation with further classification of authoritarian regimes. Atil et al., (2020), studied on the NRR of Pakistan's wealth and financial development are positively correlated. The results indicated the economic growth suffers when NRR increases sustainability. Natural resources-environmental nexus effects gain much importance by the researchers, this study incorporates natural resource rents to examine what the outcomes would have been if the inquiry had been conducted using different modelling techniques and countries.

2.1.7 Sustainable Economic

The most pervasive factor in the relationship between environmental degradation and economic growth is economic growth. Growth in an economy has a number of serious negative effects on the environment in addition to improving power integration and ensuring a nation's standard of living (Guo & Ma, 2009). Most researchers, Bekhet et al., (2017); Bilgili, Koçak, Bulut, (2016); Kuloglu, (2017); Elliott, Sun, & Zhu, (2017); Ertugrul, Cetin, Seker, & Dogan, (2016), measure it using real GDP. Significant economic growth and environmental degradation are strongly and favourably correlated, according to many researchers, R. A. Begum, Sohag, Abdullah, & Jaafar, (2015); Jayanthakumaran et al., (2012); Omri, (2013); Saboori & Sulaiman, (2013); Sadorsky, (2009); Tiwari, et al., (2013). Samour et al., (2019) examined the impact of the country's growing banking sector on environmental pollution. ARDL estimates that the expansion of the banking sector has increased the country's energy consumption and environmental pollution. Although this result is significant, it needs to be cautiously interpreted because the research was only conducted on the Turkish banking industry. If the other economic sectors were considered in the assessment, there is a substantial possibility that the outcomes would have changed. Given that the study was conducted at the corporate level, the results should be treated with caution.

The relationship between GDP, energy use, and environmental pollution was explored by Waheed et al., (2019) in both single-nation and multi-nation studies. Economic growth typically refers to a sustained increase in a nation's per capita yield over a longer period of time. The level of economic growth reflects the rate of increase of an area's total monetary volume over a given period of time and also reflects the rate of growth of a nation's overall financial strength (Petrakis, 2020). The survey's primary considerations were nation coverage, modelling techniques, time frames, and empirical results. The conclusion hypothesized that environmental pollution in industrialised countries have not been connected to economic development in the disclosures. An important contributing reason to excessive CO_2 emissions has been recognized as rising energy consumption in developed countries. The academic community values these findings much, but caution should be exercised in interpreting them stated by Chen et al, (2022). There can possibly be additional models that can be investigations to consider. Researcher examine what the outcomes would have been if the inquiry had been conducted using different modelling techniques and countries.

2.1.8 Foreign Direct Investment

The definition of foreign direct investment provided by the international monetary organization is the most popular. The IMF defines foreign direct investment (FDI) as an acquisition of a minimum of ten percent of the voting rights or common shares in a public or private company by non-resident investors. Earnings reinvestment is a type of direct investment that involves a long-term ownership in an organization's management (Agrawal & Khan, 2011). In recent years, there hasn't been much thought given to FDI's role in green growth. But for two reasons, FDI has the potential to be quite important. First off, because to its size and recent quick growth, FDI is a crucial source of capital. examining climate change-related financial transfers from developed to developing countries (Golub et al., 2011). Today, it appears that investment is a crucial component of any nation's growth and development. Particularly, foreign direct investment (FDI), which developing nations once viewed as a tool utilised by wealthier nations to exert dominance over their economies. However, the advent of globalisation and its accompanying structural modifications and international legislation has promoted economic integration and eliminated the distance that earlier prevented trade between states from happening. Developing nations are currently engaged in a strong battle with one another to draw in FDI and other fresh investment sources. In fact, FDI inflows can offer direct finance resources to produce favourable externalities, spur economic growth through the transfer of technology, a cascade effect, productivity improvements, the introduction of new procedures, and the development of managerial abilities (Lee, 2013). By contrast, they are regarded as one of the main causes that can result in environmental deterioration. Therefore, implementing solid economic policies should start with a deeper knowledge of the intricate relationships that exist between environmental degradation, FDI inflows, and economic growth (Omri, Khuong, & Rault, 2014).

According to researchers, only superior knowledge and managerial techniques can keep worldwide businesses operating successfully on soil from foreign by means of FDI (Narayan and Doytch, 2016). It’s a proven truth, FDI is a dependable source for increasing GDP capabilities, transfer advanced technology, and increase investments through provisional funding (Sirin, 2017). Additionally, a lot of work has been written that examines the connection between FDI and energy usage. By growing and extending the manufacturing and industrial sectors. FDI can reduce energy usage. However, given current data and improvements in econometrics approaches, this crucial subject needs further research. FDI is significant from a socioeconomic standpoint, but there are numerous disagreements over its environmental impact. Several studies have demonstrated that a tendency to erode environmental commitments owing to the absence or relaxation of legislation governing polluting activities can be used to explain the influx of FDI to nations with plentiful natural resources. The main objective of FDI is to make it easier for advances and financial resources to go from the countries where they originate to other countries where the capital is invested (Zafar et al. 2019). Researcher examine what the outcomes would have been if the inquiry had been conducted using different modelling techniques and countries.

2.1.9 Renewable energy use

Two main bodies of literature focus on the relationship between solar energy and the environment. The first group of studies highlights the beneficial effects of solar energy on environmental quality. For instance, Raha et al., (2010) noted that solar energy was a significant source of renewable energy that could significantly reduce environmental pollution. Solar photovoltaic (PV) plants that are fully operational can now be installed in both urban and rural settings where connection to the grid are challenging or where there is not any electrical infrastructure. By supplying schools and primary healthcare facilities in rural areas with electricity, solar systems that are off grid can enhance the lives of locals there. Solar home systems are recommended as a cheap alternative to provide power for light and devices in off-grid remote rural locations. Cooking using inefficient traditional fuels has negative effects on both human health and the environment (such as smoke, deforestation, and indoor air pollution). On the other side, solar cooking is the most application of sunlight and lowers the need of fossil fuels. A solar oven reduces carbon dioxide emissions by 38.4 million tonnes yearly while also saving 16.9 million tonnes of firewood (Machol et al., 2013). According to several researchers, Apergis et al., (2014); Koengkan et al., (2018); Sadorsky, (2009), using renewable energy increased environmental pollution.

Multiple empirical studies have used both time series (for country-specific studies) and panel data (for a collection of different nations) to examine the effects of non-renewable and renewable energy use on environmental degradation. According to Lu, (2018), using renewable energy has resource limitations. For instance, installing solar PV modules requires land and a lot of sunlight. The global search over environmentally friendly and sustainable alternative sources of energy is being driven by the depletion of conventional fuels and their adverse effects on the environment (Nathaniel et al., 2019; Yurtkuran, 2021). Solar energy is used as a source of electricity in concentrated solar energy facilities for solar thermal uses (Gonzalo et al., 2019; Wilberforce et al., 2019), photovoltaic (PV) solar energy plants (Ram et al., 2018; Rezk et al., 2019), photoactivated battery cells (Li et al., 2019), hydrogen fuels (Sharma et al., 2017), and the conversion of carbon dioxide into storable solar fuels (Xu et al., 2018). Seven South American nations were chosen, and Koengkan et al., (2018) estimated the impact of hydroelectricity usage on CO_2 emissions from 1966 to 2015. It was shown that using hydroelectricity led to longer-term increases in CO_2 emissions. These contrasting results compel us to look more closely at the dynamic interaction between solar energy use and environmental pollution.

Similar to this, in order to investigate the effects of using renewable energy on the environment for the BRICS (Brazil, Russia, India, China, and South Africa) countries during the 1990-2015 period, used the Augmented Mean Group (AMG) estimator. The results showed that renewable energy consumption correlates with environmental pollution decrease in Brazil, India, China, and Russia but not South

Africa after correcting for both cross-sectional dependence data difficulties. Although these studies have confirmed that renewable energy has the potential to reduce environmental pollution, some of the earlier research has questioned the idea that using renewable energy automatically results in a drop in emissions. Among these, used panel quantile estimation methodologies and came to the conclusion that using renewable energy sources cannot lower environmental pollution levels in the circumstances of the considerably more polluted Southeast Asian countries. The second set of empirical research highlights the amazing role that solar energy plays in lowering environmental pollution. For instance, De Chalendar et al., (2019) expressed their doubt on solar energy's ability to help cut environmental pollution. Chen et al., (2019) examined the connection between environmental pollution and renewable energy in China from 1995 to 2012. It was shown that the utilisation of renewable energy has varying effects upon CO_2 emissions in different regions of China. Compared to other conventional energy sources, solar energy is quite cheap. Numerous uses are possible for solar power systems, which also have low ongoing maintenance expenses (Chen et al., 2019). Nathaniel et al., (2019) looked at the effects of both renewable and non-renewable energy sources on the environment in African nations between 1990 and 2014. The biggest drawback is that they are vulnerable to weather changes, necessitating the construction of a system for storing energy and increasing the overall cost of the technology (Wilberforce et al., 2019). From 1991-2020, the use of solar power will have increased dramatically, going from being used sparingly to becoming a commonplace source of electricity. Since the invention of solar panels in the 1950s, many nations have shifted to the production of solar energy. China is currently the world's largest user of rooftop solar power, followed by the US, Japan as a whole and Germany (Jäger-Waldau et al.,2020).

Technology innovation has sparked efforts to replace an alternative source of energy with traditional sources, along with the efficiency of getting energy via renewable sources is continually rising. The use of solar power is a viable option as it is a clean, renewable, as well as widely accessible source. This is rapidly altering, nevertheless, as a result of global initiatives to mitigate climate change and enhance energy access as well as security (Usman et al., 2020). Another study, Destek et al., (2020), looked at the connection from solar energy and emissions of carbon dioxide using data from the G7 nations between 1991 and 2014. Solar energy was determined to have no discernible impact on environmental pollution. According to Sharif et al. (2020), using renewable energy has a considerable detrimental impact on environmental deterioration. Usman, Iorember, and Jelilov (2021) and Iorember et al. (2020) also discovered a decreasing effect of using renewable energy on environmental degradation. Nathaniel et al., (2020); Usman et al., (2020), found that using renewable energy in both South Africa and the US reduced ecological footprint and enhanced environmental quality. According to empirical calculations, using renewable energy reduced environmental pollution while using non-renewable energy increased them (Magazzino et al., 2021; Zhang, *et al., 2021).* A method based on machine learning was used to assess how wind and solar power affected carbon dioxide emissions in the United States, China, and India. Wind and solar power were found to lower environmental pollution in both China and the USA, but not considerably in India. The scientists did, however, acknowledge that states in Southeast Asia, which are generally less polluted, are more likely to succeed in reducing environmental pollution by consuming more renewable energy. For instance, Usman, Iorember, Jelilov, Işik, et al. (2021) proved that in a country with abundant financial resources like the United States, the use of non-renewable energy increases environmental degradation while the use of renewable energy decreases it. According to Lebbihiat et al., (2021), renewable energy is a term that refers to sources that are replenished and can be used again many times. It includes hydro-power, wind, biomass geothermal and solar. According to Awan et al., (2022), these energy sources included in the eco-friendly sources. In most literature it is mentioned that these energy sources are better than the non-renewable energy like fossil fuels. Renewable energy sources are becoming more and more important as concerns about energy scarcities, climate change, and the viability of environmentally friendly practises develop (Raihan & Tuspekova, 2022b). Because of the continuous depletion of fossil fuels and the negative environmental repercussions of their use, the world's economies are increasingly being compelled to adopt renewable energy sources (Raihan et al., 2022a). This is happening despite the fact that fossil fuels have been around for millions of years. When renewable energy sources are used, the amount of energy consumed globally can be decreased over time while keeping the same level of economic productivity (Raihan & Tuspekova, 2022c). Renewable energy is a type of energy that does not contribute to the atmospheric emission of carbon dioxide, and may help with issues with energy security. In order to battle climate change and promote the sustainable growth of the global economy, innovation in renewable energy technology is now essential (Lee, He, & Xiao, 2022). Additionally, energy poverty is significantly reduced as a result of the advancement of renewable energy technologies (Lee, Yuan, et al., 2022). The use of renewable energy sources is essential if the target of cutting global emissions by 50% by the year 2050 is to be met (Raihan & Tuspekova, 2022d).

The AMG method was also used by, who stated that REU is not the answer to low-carbon in Africa. Additionally, discovered evidence that suggests renewable energy is not all that helpful at reducing environmental pollution for the cases of specific MENA nations. The authors stated that these nations' renewable energy sectors aren't robust enough to have impact on carbon dioxide. Considerably expand the consumption in nuclear and renewable energy, welfare policies included in the growth strategies (Murshed et al. 2022). This study investigate what the outcomes would have been if the inquiry had been conducted using different modelling techniques and countries.

2.1.10 Financial Development

Investments made with the help of FD, such as giving additional money to startup businesses, may make it easier to begin or develop the renewable energy sector. For FD, many proxies are used by various researchers. For instance, Beck and Levine (1999), calculated the percentage of GDP for broad money (M2) and liquid liabilities (M3). The issue with these measurements is that they don't accurately reflect the development of the financial sector, but rather just how much money is being spent (Demetriades & Hussein, 1996; Jalil & Feridun, 2011). On the other hand, domestic credit to the private sector through loans, securities, trade credit, and other receivable accounts that adequately establish a claim for repayment. Additionally, credit given to the private sector shows the true amount of savings that can be used by the private sector more effectively and efficiently than the public sector (Ang, 2009). The availability of financial resources, according to Tamazian et al., (2009), supports the use of cutting-edge technology at a reduced cost and drives investments in environmentally beneficial initiatives. In earlier studies, a large number of researchers used domestic credit to the private sector (percentage share of GDP) as an indicator of financial sector development (Acaravci, Ozturk, & Acaravci, 2009; Boutabba, 2014;

Javid & Sharif, 2016; Shahbaz, Tiwari, et al., 2013), whereas a large number of researchers discovered that financial sector development has a significant role in reducing environmental degradation (Halkos & Polemis, 2017; Jalil & Feridun, 2011; S. Li et al., 2015; Nasreen et al., 2017; Shahbaz et al., 2018; Shahbaz, Tiwari, et al., 2013; Tamazian et al., 2009)

FD increases FDI, which spurs technological advancements and helps to lower energy use (Chang, 2015). According to Salahuddin et al. (2016), Businesses having information on financial resources have lower financial costs, which increases energy-intensive manufacturing activities that reduce environmental pollution both in the long and near term. Saud and Chen, (2018) rise in finance activity stimulates economy and has a detrimental impact on environmental quality. According to Park et al., (2018), financial development helps industrialised countries lower their environmental pollution since these institutions lend money to R&D and renewable energy projects that boost energy efficiency and cut environmental pollution at low interest rates. It is considered that by promoting economic activity, a developed financial sector aids in the nation's economic progress (Yang, 2019; Raheem et al. 2020; Guru et al., 2019). As a result of these financial-driven economic activity, energy demand has increased (Sadorsky 2011; Shahbaz et al. 2018; Samour et al. 2019). According to Atsu et al, (2021), expanding finance service improves energy efficiency. By reducing credit restrictions, financial development promotes businesses to invest in eco-friendly projects. Researcher examine what the outcomes would have been if the inquiry had been conducted using different modelling techniques and countries.

2.1.11 Labour force

A demographic subdivision of the population is the labour force. Earlier research, including that by Joshua, Alola & Salami, (2020) use population to examine the FDI-growth theory in the context of a country (Nigeria) were also used by Joshua et al. (2020) to support that population is the potential variable in establishing a link between FDI-GDP in the country (South Africa). Therefore, labour force structures are defined by population patterns

2.1.12 Gross Savings

Domestic saving, despite its many conceptualizations, is crucial to a nation's growth since it is the major source's funding for activities like investment and the creation of initiatives that advance socioeconomic progress. Savings rates and the amount of investments made as a result are crucial factors in determining whether a country will become a major economic force. Savings are the important for the accelerate the economic growth process in developing nations (Volkan Kaymaz, 2021).

2.1.13 Infrastructure

Infrastructure is necessary for a healthy lifestyle of public. For example, broad roads decrease accident's ratio and safety for public, a system of water supply lowers the illness rates, and waste control enhances environmental health. In present day, mobile is a crucial industry for fostering global trade, FDI, and economic expansion. In their research of the application of SDPs, Grundey, 2008; Burinskiene and Rudzkiene, (2009), identify infrastructure development as one of the most critical elements of long-term strategic planning for the nation's socioeconomic and spatial sustainability. International trade affects FDI influx more favorably in developed countries, andit also work in developing countries (Choi et al., 2022).

2.1.14 Merchandise Trade

Regardless of whether a country is developed or developing, trade is an important factor in evaluating GDP-growth (Were, 2015). The mixed affects of trade on GDP-growth and environmental pollution in the country (Brazil) have been documented by (Hdom and Fuinhas, 2020). Long-term environmental deterioration has decreased due to trade openness as a result of 24 OECD nations' strict regulatory compliance with sustainable development objectives (Destek and Sinha, 2020)..

2.2 Inter Variable- Literature Review

In this segment, the connection between the factors that are independent (green finance, urbanisation, economic growth, natural resource rents, FDI, and international trade) and the variables that are dependent (environmental pollution and energy efficient) is investigated. The objective is to examine the impact of these independent variables on the achievement of environmentally friendly development goals and the promotion of renewable energy adoption.

2.2.1 Economic Growth And Environmental Pollution Nexus

Alege and Ogundipe (2013) looked into the relationship between the quality of the environment and economic growth and found that there was a statistically significant and positive connection between the two. Similarly, Using the model of vector error correction (VECM), Muftau, Iyoboyi, and Ademola (2014) looked at the relationship between economic development and environmental pollution in West Africa from 1970 to 2011 and discovered that there was a statistically significant and favourable connection between the two. According to empirical evidence, CO_2 is the pollutant that experimentally has the greatest impact on global warming (Pachauri et al., 2014). The majority of scientists have represented many forms in the association between economic expansion and environmental degradation, including inverted U-shaped, and N-shaped. Alkhathlan, Alam, & Javid, (2012); Bekhet et al., (2017); He, Xu, Shen, Long, & Chen, (2017); Jalil & Feridun, (2011); Jayanthakumaran, Verma, & Liu, (2012); Saboori & Sulaiman, (2013); Sehrawat et al., 2015; Zi, Jie, & Hong-Bo, (2016) and Uddin, (2020), according to the goals of the studies and the most important factors influencing pollution emissions in a particular economy or group of economies, several methods have also been used to assess these correlations. Rahman, (2017), emphasised that Shahbaz et al., (2013), found that the net impact of economic expansion on emissions could be either beneficial or negative. A country can increase its access to the global market through free trade, which can boost its competitiveness and efficiency, according to the theory behind a beneficial influence. Thus, the nation can import environmentally friendly technologies from industrialised nations, thereby lowering carbon emissions. However, Kasman and Duman (2015) demonstrate a causal relationship between environmental pollution and economic indicators. According to Bai et al. (2020), pollution to the environment is a significant long-term inhibitor of economic growth. Nations must immediately begin to advance renewable energy sources in order to stop environmental damage if they want to accomplish a green economic transition. Namahoro et al.,(2021) used a symmetry analysis to examine nations with different income levels and discovered that energy intensity causes a rise in emissions. They also observed that economic growth had variable effects on emissions depending on the country. Additionally, their data support the idea that using more renewable energy results in lower emissions. Growth and emissions have a two-way relationship where they have an impact on one another, according to Pejovic et al., (2021) causality analysis. However, their study also discovered that using renewable energy frequently reduced emissions. Additionally, any economy's governance indicators would aid in the transition to renewable sources.

Theoretically, when a nation experiences greater economic growth, there is a possibility of increased commercial and industrial activity, which will inevitably result in higher environmental pollution. The impact of macroeconomic, microeconomic, and social factors on environmental pollution has been examined in several research. According to the recognized research, economic expansion is the key factor affecting environmental pollution. This subject has been thoroughly studied in numerous studies. While other studies examine the symmetrical or asymmetrical impacts of economic growth on pollution emissions, some investigations evaluate the EKC in the link between economic growth and pollution emissions. According to theory, academics have stressed the applicability of the Grossman and Krueger, (1995), environment Kuznets curve (EKC), which holds that the pursuit of economic development (EG) has an impact on environmental quality. Recent research have supported the EKC theory, showing that increased economic growth may result in a decrease in environmental pollution (Chen et al., 2022; Khan et al., 2022; Laverde-Rojas et al., 2021; Ostic et al., 2022).

2.2.2 Renewable Energy Use and Environmental Pollution Nexus

The interaction between REU and EVP has mostly been highlighted in environmental research. Apergis and Payne (2010) examined the relationship among nuclear energy, economic growth, environmental pollution, as well as renewable energy in a sample of 19 nations, both developed and developing, as well as concluded that green energy plays no significant role in reducing environmental pollution. In addition, Farhani and Shahbaz (2014) investigate the relationship among environmental pollution, energy from renewable sources consumption, and economic growth for a sample of 12 MENA economies. The results demonstrate bidirectional causality between renewable energy and carbon emissions. Bilgili et al. (2016) examine the validation of the environmental Kuznets hypothesis for 17 OECD economies by factoring the role of energy from renewable sources into the environmental framework. The findings indicate that renewable energy contributes positively to the reduction of environmental pollution. Moutinho and Robaina (2016) examine the long-term and short-term connection among real income, generation of electricity, and environmental pollution for a sample of twenty European economies. Renewable energy has the potential for lowering carbon emissions and may account for variations in the association among income and carbon dioxide emissions across European economies, according to the study's findings. Zoundi (2017) examines the impact of the use of renewable energy on the quality of the environment in the context of 25 designated African economies. No proof of a complete verification of EKC predictions is shown by the outcomes. However, it has been discovered that environmental pollution rise as per capita income does. The total projections clearly show that renewable energy is still an effective replacement for traditional fossil-fuelled energy, even though it has a negative impact on environmental pollution and a growing long-term effect. However, primary energy consumption outweighs the effects of renewable energy in the short- and long-term as well, necessitating greater global synergy to overcome environmental problems. Belaid and Youssef (2017) examine the relationship between economic development, both green and fossil fuel consumption, and carbon dioxide emissions for the Algerian economy. The results indicate that consumption of non-renewable energy and economic growth have a negative impact on environmental pollution, whereas consumption of renewable energy substantially contributes to environmental improvement. The significance of REU in raising environmental quality has just come to light (Cheng et al., 2019, Baloch et al., 2019, Dong et al., 2017). Numerous research have examined the necessity of using nuclear energy (NU) to lessen environmental deterioration (Dong et al., 2018a, Dong et al., 2018b). Other ecological determinants include financial development, trade openness (Haug and Ucal, 2019; Shao et al., 2019), agricultural activities (Balsalobre-Lorente et al., 2019a; Balsalobre-Lorente et al., 2019b Liu et al. 2017), and natural resources (Haug and Ucal, 2019; Baloch et al., 2019). Current energy economic research (Hafeez et al., 2019) is increasingly concerned with the impact of clean energy sources on the quality of the environment. In addition, Kahia et al. (2019) examine the same link for eleven net oil-importing economies in the MENA region and demonstrate the in both directions causal association between variables. Chen et al. (2019) examine the relationship between China's international trade, both green and fossil fuel consumption, growth in the economy, and environmental pollution. The findings indicate that an increase in per capita GDP and use of fossil fuels increases environmental pollution, whereas an increase in consumption of renewable energy reduces carbon dioxide emissions (Shen et al., 2021). According to Zafar et al., (2020), the causes of renewable energy usage have an important and beneficial effect on the environment by reducing the amount of carbon dioxide in the air. Similarly, investments in renewable energy sources produce fewer carbon emissions than conventional energy sources. By increasing the consumption of renewable energy, economies experience an improvement in the environment and develop a pure and globally green climate framework. In the past two decades, there has been a lively debate regarding the rapid expansion of clean energy sources and its impact on economic development and the quality of the environment (Mofijur et al., 2021). According to Dogan et al., (2021), REU is thought to reduce environmental pollution and problems with energy security. REU is used by businesses for manufacturing and production in an effort to increase growth and productivity with less waste and lower EVP. Research has shown that REU has a major impact on EG, which has a long-term impact on EVP. Agbede et al., (2021) investigated into the relationship between NEU-EVP in the MINT nations. They said that the use of energy quickens the rate of EG and will cause environmental deterioration in these nations. A reduction in inequality of income triggers carbon dioxide emissions in Russia, China, and Brazil, in that order (Zhao et al., 2021). Suki et al., (2022), also examined the relationship between REU and EGC. The findings reveal that the use of renewable energy contributes to the reduction of environmental degradation. Additionally, technological innovation reduces carbon emissions and ecological footprint.

2.2.3 Green Finance And Environmental Pollution Nexus

Recently, the relationship between GFN and environmental quality has come to dominate environmental research and policy. Some academics have praised the idea of using GFN to advance environmental quality. GFN was defined by Wang and Zhi (2016) as the incorporation of financial and economic choices that are most advantageous to environmental preservation. Based on the data of 23 nations with the greatest utilisation of renewable energy, (Dogan & Seker, 2016b) found that financial development has the potential to effectively reduce domestic carbon dioxide emissions.Financial institutions themselves contribute to the improvement of environmental quality. This is because, on the one hand, the finance industry may offer financial support to obtain environmentally friendly companies and initiatives, and, on the contrary, financial development can promote the improvement of industrial structure, that plays a significant role in decreasing energy consumption and carbon emissions (Nasreen et al., 2017). According to Scholtens, (2017), the rapid development of financial technology has a significant impact on numerous aspects of human society, but has little effect on the ecological environment; thus, there is an enormous chance to promote ecological environment via financial funds. The obvious solution to this huge financing gap is financial capital (Clark et al., 2018). In addition, Wang & Zhi, (2016), have looked into the more basic issues of green finance that support sustainability, such as how to bring the benefits of green financing to the environment, how they can enhance the engagement of private the colour green capital in protecting the environment projects, Taghizadeh-Hesary & Yoshino, (2019), and the government's role in encouraging the growth of green finance (Owen et al., 2018). Poberezhna, (2018), investigated the advantages of green economy as well as blockchain technology as a means for addressing the world's water scarcity issue and lowering the risk of environmental degradation. According to Gianfrate and Peri, (2019), green bonds are one of the most significant financial instruments for achieving the Paris Agreement's carbon reduction goals. According to Glomsrd & Wei, (2018), 4.7 Gt of carbon dioxide can be prevented from being released into the atmosphere by 2030, while the proportion of non-fossil energy power rises from 42 to 46% due to the growth of green finance. Guo et al., (2019), refined the financial indicators and found an inconsistent relationship between financial magnitude, financial efficiency, and carbon dioxide emissions. Furthermore, it was discovered that financial growth can reduce emissions of numerous environmental indicators, such as industrial solid waste, industrial effluent, and nitrogen oxides (Nassani, Aldakhil, Abro, et al., 2017). The significance of establishing green finance therefore resides in enhancing the characteristics of finance that can improve environmental quality. Nawaz et al. (2021) see GFN as a broad notion related to financial investment aimed toward sustainable development initiatives and activities that increase environmental quality in addition to this definition. In a similar vein, Wang et al. (2021) hypothesized that GFN aids in reducing environmental degradation by encouraging business expenditures in technology, such as (non-fossil innovation investment), which upholds environmental quality. Nevertheless, research on the connection. The relationship between GFN and EVP is still a subject of inquiry, though. The impact of GFN on EVP among the top 10 economies with the highest GFN investment was studied by Saeed Meo and Karim in 2022. According to their research, GFN and EVP have an antagonistic relationship. According to their research, GFN is a useful strategy for improving environmental quality.

2.2.4 Natural Resource Rent And Environmental Pollution Nexus

Coal and crude oil are the two main natural resource rent sources in these economies But throughout the years, these nations have experienced a significant deforestation rate that has decreased the natural forest cover and their natural assets (Nabangchang and Srisawalak, 2008). These economies also generate a sizable amount of mineral and natural gas rents. On the other hand, nations like South Korea and Japan rely on imported non-renewable energy sources. Both renewable as well as non-renewable energy resources are available in ASEAN and East Asia (Chang and Li, 2014).

The relationship between NRR as well as carbon emission has been extensively studied in both developed and developing economies (Chien et al. 2021b; Chien et al. 2021g; Li et al. 2021). In this regard, one of the most recent contributions is Bekun et al. (2019), who observe sustainable environment trends while analyzing the relationship among resource rent, emissions of carbon, and other explanatory variables in 16 EU economies from 1996 to 2014. The panel aggregated mean group-autoregressive dispersed lagged model had been applied to the data analysis. Long-term estimations reveal a positive correlation between the NRR of nations and their carbon emissions. Ullah et al. (2021) investigate the nonlinear relationship among NRR and environmental impact for the 15 clean energy economies with the highest NRR. From 1996 to 2018, data were collected in order to implement the panel seamless transition model. Both high-income and low-income regimes exhibit a significant and positive correlation among NRR and ecological footprints. Tufail et al. (2021) offer their empirical insights while investigating the significance of natural resources as well as fiscal decentralization in addressing carbon emission in OECD economies from 1990 to 2018. However, the findings of the study seem to indicate natural resource rent benefits the environment through decreased carbon emissions. Joshua and Bekun (2020a) performed an empirical study to examine the impact of consumption of energy and the NRR to assess South Africa's carbon emissions. South Africa's economy has a long-term relationship between pollutant emissions and total NRR, according to the findings of this study. Wang et al. (2020) analyzed the influence of NRR and other macroeconomic factors in addressing emissions of carbon for the G7 nations. The results of the study indicate that NRR increases carbon emissions in nations in the G7. While evaluating for the EKC, Huang et al. (2021) considered the significance of energy consumption along with NRR in determining

China's carbon emission from 1995 to 2019. The study's findings affirm that NRR has significant implications for the Chinese economy's environmental quality. In addition, several studies have examined the relationship between NRR with environmental issues such as emissions of carbon (Canh et al. 2020; Chien et al. 2021; Joshua and Bekun 2020; Li et al. 2021; Ulucak and Ozcan 2020). Bekun et al. (2019) conducted a literature review to examine the long-term causal relationship between the use of natural resources rent, carbon dioxide emissions, and environmental degradation. This study's empirical evidence is based on panel information for specific 16 EU nations from 1996 to 2114. Panel pooling mean group-autoregressive an autoregressive distributed lag model (PMG-ARDL) was used to analyze the data. This study examines the effects of energy resources on environmental pollution, and the findings reveal that if appropriate management or conservation techniques are not implemented, rent for natural resources increases CO_2 emissions into the atmosphere. Ullah et al. (2021) conducted empirical research to determine the interrelationships between the use of renewable energy, natural resource rent, carbon dioxide emissions, and environmental quality in the setting of the world's top 15 renewable energy consuming economies in order to achieve sustainable development. 1996–2018 panel time-series data are utilized for this research. Utilizing a panel smooth transition model, the relationship as well as transition among the low and high regimes are investigated. This study reaches the conclusion that natural resource rent increases environmental pollution and contributes to environmental degradation. Recently, Razzaq et al. (2021) examined the resources degradation effect attributable to construction of infrastructure in highly resource-consuming economies along with claimed that innovation can aid in mitigating these negative effects. Recent research using OECD, China, as well as BRICS samples, respectively, confirms similar outcomes (Razzaq et al., 2021).

According to Hassan et al. (2019), NRR enhances environmental protection, which benefits economic growth. Although natural resource rents can boost an economy's prosperity and progress, it is also possible that these nations may experience the theory of the resource curse (Li et al., 2020). Therefore, a country's overall environmental performance, among other things, will determine whether resources are a blessing or a curse. Natural resource rent (NRR) is crucial to the development of most nations, especially emerging economies. These nations typically rely on the extraction of natural resources for economic development (Xue et al., 2021). According to Huang et al. (2021), who examined the relationship between NRR and EVP, NRR will result in a decline in environmental quality in the United States of America if the appropriate measures are not put in place. According to Razzaq et al. (2020), a higher level of environmental deterioration occurs in the USA as a result of NRR depletion. Additionally, Ibrahim & Ajide (2021) reported that in the economies of the BRICS countries of Brazil, Russia, India, China, and South Africa (BRICS), NRR, financial development, and regulatory quality led to EVP. Interestingly, Tufail et al. (2021) discovered that among the 10 most recently industrialised nations, NRR helps to reduce environmental pollution.

2.2.5 Urbanization and Environmental Pollution Nexus

People moving from rural to urban regions is known as urbanization (URB). Urbanization (URB) is now universally acknowledged as one of the prerequisites for global growth. Poumany vong and Kaneko (2010) predict that URB will increase global population to 4.6 billion by 2030. It is anticipated that the 50% of this population residing in cities will use more than 50% of the world's energy and increase environmental pollution by more than 60% (Shahbaz et al., 2015). However, the numerous negative effects linked with URB, a significant portion of environmental pollution have shown this idea to be fruitless (Behera and Dash, 2017). Despite all of its flaws, URB has seen a noteworthy increase of roughly 50% in the first decade of the twenty-first century worldwide (Behera and Dash, 2017). With this dramatic increase in URB, factors such as inefficient industrial expansion, rapidly rising automotive demand, expanding middle-class incomes, and urban clusters have increased global CO_2 effusions through energy consumption (EC) (Behera and Dash, 2017; Dogan and Turkekul, 2016).

Using a generalized method of moments (GMM) approach, Hanif (2018) examines the impact of urbanization on Sub-Saharan African countries' carbon emissions from 1995 to 2015. The findings of the study indicate that the growth of urban areas contributes substantially to carbon emissions in the selected economies. Zhang et al. (2018) carried out an empirical study to determine the connection among urbanization as well as environmental pollution. The study uses panel data from 2005 to 2014 and the randomly distributed influences by regression on population, wealth, and technology (STIRPAT) model to investigate the effects of urbanization on carbon dioxide under the modification of central gravity. This study investigates various aspects of urbanization, including population and land use urbanization. Its findings imply that urbanization contributes to an increase in environmental pollution in the country. In recent years, Khoshnevis Yazdi and Dariani (2019) showed that there is a direct correlation between urbanisation and environmental pollution levels in newly developing regions. This association is a result of the economic pressure governments confront to create jobs while also driving increased energy usage. Zhou et al. (2019)

have investigated the effect of urbanization on China's carbon emissions. The primary contribution of the research they conducted was to look into the trends in carbon emissions by analyzing the subsystem mechanisms of urbanization. The results of the study demonstrate that the concentration of environmental pollution fluctuates over time in various urbanization subsystems. According to Afridi et al. (2019), high CO_2 effusions in both advanced and developing countries are mostly caused by EC and URB. According to Fan et al. (2019), URB and EGC play a crucial transitional role in the EVP and social developments of nations. Their data also demonstrated the complexity of the relationship between URB and environmental quality. While a nation's socioeconomic situation improves, URB and economic expansion can have detrimental effects on the environment. Odugbesan and Rjoub (2020), for instance, demonstrated in a scenario that as industry planners move from agricultural centers to industrial sectors, URB increases industrial and household energy demand, leading to more technologically oriented production structures. This viewpoint holds that increased energy use and rising environmental pollution, which are known to be the main causes of environmental deterioration, are a result of economic progress and advancement along with the effects of URB. Musah et al. (2020) looked on the interactions between URB-EVP among West African nations. They discovered that URB had a direct and advantageous impact on EVP. In recent and previous years, urbanization has had a significant influence on establishing the EVP (Chien et al. 2021). In this respect, Mahmood et al. (2020) conducted a study to examine the effects of accelerated urbanization growth on environmental pollution under the conditions of industrialization. To infer the association among urbanization and carbon dioxide, the study analyzes the industrialization and urbanization in Saudi Arabia from 1968 to 2014 using annual data. The results of the study demonstrate that urbanization under the impact of industrialization has a significant positive effect on environmental pollution. It is stated that urbanization increases industrial activities, such as the use of non-renewable energy sources (the burning of fossil fuels), which are responsible for a significant quantity of environmental pollution. Prastiyo and Hardyastuti (2020) carried out empirical research on the impact of urbanization, agriculture, and industry on carbon emission levels in the Indonesian economy. In addition to confirming the presence of EKC, the study concludes that urbanization along with other explanation factors are responsible for the escalation of greenhouse gas emissions in Indonesia. Zhang et al. (2020) investigated the cross-country analysis of urbanization's effect on environmental pollution. On the basis of the extended STRPAT framework, data was gathered from 141 nations during the period 1961–2011 for this purpose. The results of the analysis indicate an inverted U-shaped relationship among urbanization as well as carbon emission. Numerous academics are still investigating the effect of the URB mechanism on EVP because it is a pertinent topic (Zhang et al., 2021). Musah et al. (2021) examined the relationship between emissions of carbon and urbanization in West Africa using a variety of statistical methods. The study found that urbanization has an important and beneficial impact on environmental pollution in all panel economies. Dong et al. (2021) examine the impact of urbanization and industrialization on environmental protection and the economy by focusing on urbanization and industrialization. From 2002 to 2017, data were collected, and panel estmiating analysis was used. Carbon emissions are negatively associated with urban health, as a 1% increase in the amount of environmental pollution may result in 0.162% more inpatients in the Chinese economy. Population and carbon emissions have ascended to become two of the most significant obstacles to the sustainable growth of society, according to Wang and

Wang (2021). For this reason, their study analyzed the impact of population aging on carbon emissions by developing a panel threshold regression model for 137 economies over the period 2002–2012. There is an upward trend between industrial facilities and carbon emission as the population ages (Zhao et al., 2021). Chien et al. (2021) and Huo et al. (2021) take the construction industry into account when determining the relationship between carbon emissions and urbanization. The study confirms that rural residential construction will be the first sector in China to attain emissions and energy peaks. Although the researchers provide sufficient evidence from the literature to support the link among urbanization and carbon emissions, their regional verification, particularly in the United States, is still lacking. This suggests a theoretical and regional lacuna that is adequately addressed by the current study analysis.

More research is now required to better understand the relationship between carbon dioxide emissions and urbanisation, as evidenced by the recent proclamation of a carbon neutrality strategy by fast rising economies like China (Zhang et al., 2021). Developing economies with poor governance systems and urbanisation initiatives might further worsen any environmental repercussions felt, even while rising carbon levels pose a serious danger to environmental quality (Chen et al., 2022). Given this circumstance, the EKC serves as the primary theoretical lens through which our study explores the integrated effect on environmental pollution levels. It's crucial to note, however, that while there have been some questions regarding the theory's robustness, Researcher have also included a number of pertinent experiments, particularly the FMOLS and DOLS techniques, to assist validate our results.

2.2.6 Foreign Direct Investment and Environmental Pollution Nexus

Numerous studies have been carried out to investigate the relationship between FDI and environmental pollution. However, the results have been inconsistent. For instance, For a panel of BRIC nations, Pao and Tsai, (2010), examined the relationships between FDI and environmental pollution. Their Granger causality analyses revealed that there was a significant bidirectional causal relationship between these variables from 1992 to 2007 according to the results. Huang et al., (2019), looked into how FDI and environmental pollution in Chinese provinces are related. The study's findings confirmed that FDI is a factor that negatively affects environmental pollution. This information is extremely important, but since the investigation was only conducted in Chinese provinces, it is appropriate to generalized the findings to all nations. If other provinces, regions, and counties in other jurisdictions had been included in the study, the results might have revealed a different picture. The study conducted on Vietnam, Minh, (2020), identified FDI as a significant source of CO_2 effusions. Although this investigation is interesting, the time series approach it used calls for some care in how it interprets its findings. The result might have been different if the study had used the panel data approach by included additional nations in its sample. Our research, which used panel data, is crucial because it provides findings that further the discussion of FDI-CO_2 effusions.

Ahmad et al. (2020) conducted a research study on the OECD region and found that FDI is a critical factor in the promotion of environmental pollution. This result conflicts with that of Huang et al., (2019), for Chinese provinces but supports that of Li et al. (2020) and Minh (2020) for Vietnam. These contradictory findings imply that the issue over the relationship between FDI and the environmental pollution is far from settled and call for more investigations like ours. In their 2019 study, Sarkodie and Strezov focused on five developing economies. The rate of CO_2 effusions in the countries increased as a result of the disclosures. This study is incredibly important, however because it only included underdeveloped countries, its findings cannot be applied to all countries. The results might be different if the exploration were to be undertaken on developed nations. In their study on developing countries. Dhrifi et al., (2020), confirmed that FDI can reduce environmental pollution. This finding contradicts that of Dou and Han, (2016), but supports that of Zhang, (2016) and Zhou, (2019). These contradictory results suggest that further research on the relationship between FDI and environmental pollution is required. Therefore, conducting a study like ours was really important. Guzel and Okumus, (2020), discovered that FDI was a major factor in the promotion of environmental pollution excretions in ASEAN nations. This information is really valuable, although the study was only done in ASEAN nations. Therefore, it is important to use caution when interpreting the results because the conclusions might be different if data from other countries were included in the analysis.

2.2.7 Financial Development and Environmental Pollution Nexus

"Financial development" is a significant environmental quality indicator. but some studies contend that financial development also raises environmental pollution because it eases credit restrictions in the economy and boosts Gross Domestic Product (GDP), which in turn raises environmental pollution. According to Dasgupta et al. (2001), the growth of the stock market decreases financing costs and increases corporate liquidity, allowing them to enhance production and, as a result, energy consumption and environmental pollution. According to Sadorsky, (2010), effective financial intermediation expands loan opportunities, enabling consumers to purchase pricey goods like cars that raise carbon emissions. Another study team supports financial growth because it boosts investments in cutting-edge technology that could lower carbon emissions (Zafar et al., 2019). As a result, in addition to analysing the role of energy efficiency and environmental pollution, this study also discusses financial development. The validity of the empirical findings may be questioned if this important component is ignored. Dogan and Turkekul (2016); Lu, (2018) for 12 Asian countries, Salahhuddin et al., (2018) for Kuwait using financial development indicators and Charfeddine and Kahia (2019) for 24 MENA nations all discovered non-significant effects of financial development on environmental pollution as well.

2.2.8 International Trade-Environmental Pollution Nexus

Transferring industrial production processes across international borders causes associated emissions to move across nations. On the other hand, research by Managi and Tsurumi, (2009), indicated a considerable negative influence of trade flows on environmental pollution. However, the effect of commerce on environmental pollution is not clear. For instance, various researchers, Ajayi & Ogunrinola, (2020); Alhassan et al., (2020); Copeland & Taylor, (2004); Halicioglu, (2009); Usman, Olanipekun, et al., (2020); Yu et al., (2019), have confirmed the beneficial effect of trade on environmental pollution. Due to their frigid environment, energy-intensive industries, vast, sparsely populated areas, long distances, and high standards of life, the Nordic countries use a lot of energy (Aslani et al., 2013). According to Brini et al., (2017), Denmark and Iceland were the top two consumers of renewable energy in 2010. This has a favourable effect on their international commerce. According to Okuneviciute Neverauskiene and Rakauskiene (2018), the government supports the production of renewable energy through tax breaks and subsidies, which lowers the cost of production compared to non-renewable energy. On the other side, trade promotes industrial production activities, which ultimately results in more carbon emissions in the atmosphere, negating the trade-in environmental pollution. Jebli and others (2019) International commerce may have a negative impact on environmental quality, according to a group investigation into emerging economies. In line with this, negative effects were discovered in empirical research conducted by Tiwari et al. (2013) in India, Halicioglu (2009) in Turkey, Gasimli et al. (2019) in Sri Lanka, and Balsalobre-Lorente et al. (2018) in five European Union nations. Countries must immediately begin to develop renewable energy technology to stop environmental damage if they want to achieve a green economic transition. Contrarily, emissions under consumption-based accounting, which is based on emissions included in trade, are the responsibility of the nation consuming the final products (Baumert et al., 2019). On the other hand, Sun et al., (2019), found no link between trade & environmental deterioration. It is notable that the variations in results may be related to variations in the countries, approaches, time periods, and environmental degradation indices employed. The adoption of renewable energy was recommended by Bilan et al. (2019) to advance global trade that is directly related to energy consumption. The connections between renewable energy and economic activities in European nations were investigated by Kasperowicz et al., (2020). Their research demonstrates the long-term equilibrium relationship between trade and renewable energy.

2.2.9 Sustainable Economic And Energy Efficiency

The oil crises of 1973–1974 and 1978–1979 marked the beginning of studies in the literature that looked at the connection among energy and economic growth. However, these research looked into the connection between energy use and economic expansion. Energy studies have shifted away from the topic of energy efficiency due to the potential of the exhaustion of fossil fuel sources emerging during the 1990s and assertions regarding the development of related environmental issues (Sener, S., & Karakas, A. T. 2019). One could assert that the ground breaking investigations in the area of energy efficiency were carried out by Brookes, (1990); Khazzoom, (1980) and Saunders, (1992). Following these investigations, Semboja (1994) utilized the computable global equilibrium (CGE) model to analyze the effects of a rise in energy conservation on the Kenyan economy. The simulation data from the study demonstrates that material or resource utilization is minimized if the rise in energy efficiency depends on international energy sources, thereby effecting foreign currency savings. Hanley et al., (2006), drew attention to the economic and environmental effects of energy efficiency enhancements by proposing an alternative strategy for energy efficiency. The results showed a 5% increase in energy efficiency in Scottish increased the GDP by 0.06, 0.10, and 0.88 percent in the short-, medium-, and long-terms, respectively. However, the study concluded that improvements in energy efficiency would have led to an increase in consumption of energy over time, resulting in substantial pollution to the environment. Similarly, Allan et al., (2007), examined the relationship among energy efficiency as well as economic growth in the United Kingdom via an economy-energy-environment CGE model. When efficiency in energy use in the manufacturing sector increased by 5%, the GDP improved by 0.11 percent in the short run and 0.17 percent in the long run, according to the findings. Destais et al., (2007), found no evidence of a linear link between income and energy demand (energy intensity) in 44 different nations. Applying a data envelopment technique for estimating the energy efficiency index in 29 regions of China, Wei et al., (2009), discovered that all provinces had significant variations in energy efficiency and that the proportion of secondary industry to GDP had a negative impact on energy efficiency (Bunse et al., 2011). On the other hand, highlighted the need for industrial firms to incorporate their energy efficiency results into their manufacturing operations within the structure of activity research and maintained that a gap existed between industrial firms and theoretical solutions. Zhang et al, (2011), measured the total factor energy efficiency via the data envelopment method to detect shifts in efficiency as time passed in 23 developing countries. The results of Tobit regression indicated a U-shaped connection between total aspect energy efficiency as well as per capita income, although measurement results varied by country. The findings demonstrated that while financial development reduces environmental pollution, economic growth and energy intensity increase them.

Sinha, (2015), who analyzed the effect of economic development in India on energy efficiency via the model of vector error correction, with wasted energy representing energy efficiency, discovered a unidirectional causal relationship between economic growth and energy waste, as well as a negative relationship among energy waste and economic growth. Zhong, (2016), investigated the link between energy use and economic growth by using two ideas: the demand and supply sides of energy use. The author found that structural breakdown causes energy intensity to be higher on the supply side than on the demand side, and that changes in sectors affect energy intensity. Bataille and Melton, (2017), investigated the financial consequences of energy efficiency enhancements in Canada using a CGE model distinguished by both sectoral as well as regional aspects from other studies. The results of their forecasting indicated that energy efficiency enhancements increased GDP by 2%, employment by 2.5%, along with household welfare by approximately 1.5% during the relevant period. Energy intensity and economic growth have been used as indicators in the majority of studies to examine the connection between energy efficiency and economic development. It has also been investigated how these two signs form a U-shaped. For the years 1996–2013, Lan-yue et al., (2017), looked at the connections between energy use, economic production, and energy intensity in nations with various levels of development. The three variables had a linear connection, they discovered. Additionally, they discovered that economic production and energy intensity, particularly in developing nations, had an impact on changes in economic consumption. Yang and Li (2017) conducted an analysis of the effects of energy investments on China's total factor sustainability and green development from 2003 to 2014. Due to investments, they discovered that Beijing and Shanghai had the greatest possible energy efficiency levels , whereas other regions of China had low levels. By examining the most important hydro power energy projects, the long-term effects of energy efficiency and sustainability on the population have been highlighted.

In 134 nations from 1990 to 2014, Deichmann et al., (2018) investigated the connection between economic growth and energy intensity. They discovered a threshold effect of income growth on changes in energy intensity by using a regression model. According to Mohmood and Ahmad (2018) economic growth and energy intensity are mutually exclusive in European nations. Using a technique based on panel smooth transition regression models. Existing research has also established the correlation between economic growth and energy intensity (Deichmann et al., 2018 and Mahmood and Ahmad, 2018). Specifically, Deichmann et al., (2018) evaluated the influence of energy intensity in the growth of the economy for a panel of 137 nations. Although the study discovered a negative correlation between the indicators, it also demonstrated the existence of a threshold in the relationship between energy consumption and economic growth, such that a turning point is reached when the per capita income reaches $5,000. In a similar vein, Mahmood and Ahmad (2018) discovered a significant and negative correlation between economic expansion and energy intensity in European nations. In addition, studies by Alola et al., (2018); Shahbaz et al., (2020) and others have discovered a correlation between renewable energy usage and economic growth. While Alola and Alola et al., (2018) established an advantageous connection between green energy usage and economic development in the Coastline Mediterranean region (CMC). In sub-Saharan African nations, Lin and Abudu (2019) examined how the development stage affects energy intensity. They discovered that low-income nations emit more carbon dioxide and had higher energy intensities. Bayar and Gavriletea (2019) found that energy efficiency resulted economic growth in 22 nations that were developing. Sener and Karakaş (2019), examined the effect of economic expansion on the efficiency of energy in 62 countries using a method distinct from their previous research. The Augmented Mean Group (AMG) estimate revealed that an increase in GDP decreased the energy intensity of the high- and upper-middle-income nations but had no effect on the energy intensity of the lower-middle-income nation group. The effect of industrialization and trade openness on energy intensity was studied by Pan et al., (2019). They confirmed that whereas trade openness directly has a negative impact on energy intensity, industrialization has a direct favourable impact. In 46 African countries between 1980 and 2011, Ohene-Asare et al., (2020) found a bi-directional link between total factor energy efficiency and economic progress from 1990 to 2013.

Pan et al., (2019) examined the connection between energy efficiency and economic development in European nations. They came to the conclusion that these two indicators formed a U. In Akdag and Yldrm (2020), which was conducted to assess the energy efficiency and impact of emissions of greenhouse gases and economic growth on European countries, it was stated that a rise in energy efficiency had a negative effect on emissions of greenhouse gases as well as a positive effect on economic growth.

Shahbaz et al., (2020) investigated the relationship among the two indicators in 38 green-energy-consuming nations. Specifically, Shahbaz et al., (2020) implemented the dynamic ordinary least-squares method (DOLS) and fully modified ordinary least squares (FMOLS), demonstrating that renewable energy utilization promotes economic growth in the sample of examined nations. In addition to the previously mentioned studies on the relationship between the intensity of energy and economic growth, the energy research is replete with analyses of the dimensions of the relationship between sources of energy and economic growth (Zeraibi A et al.,2020). High GDP per capita and high energy prices, according to Azhgaliyeva et al., (2020) result in decreased energy intensity. They also discovered that five energy efficiency policies—taxes, standards, subsidies, strategic planning, and government direct investment—lead to lower energy intensity. Based on studies on the connection between energy efficiency (energy intensity) and economic and financial development, Researcher have developed a succinct, pertinent literature overview. Energy efficiency may be linked to sustainable economic and financial development and assists the fulfillment of sustainable development goals (SDGs) (particularly SDG7) relating to energy. However, Researcher were unable to locate any specific papers discussing the relationship between sustainable economic growth and energy efficiency with the moderation factor of financial development. Since there is a research void in this area, our study fills it and offers a unique and creative research approach. Researcher examined the relationship between energy efficiency and sustainable economic growth with the moderation factor of financial development in 51 nations. More recently, Teng et al., (2020) and Destek, (2018), investigated the effects of financial indicators (different type) and economic growth on energy consumption by including three indexes—stock market index, bank indicators index, and bond markets indicators index—in two comprehensive studies using mean group (MG) and common correlated effect (CCE) estimator. They discovered a negative and strong correlation between energy consumption and financial indicators of the bond market, as well as a negative but insignificant correlation between the aggregate financial index, the banking market index, and the stock market development index. The study examined the effects of economic complexity a energy security risk on measures of energy efficiency, namely energy intensity and carbon intensity, for a panel of the 25 top energy use countries. The empirical results from quantile regression analysis for the full panel of countries shows that an increase in economic complexity raises energy efficiency through lower energy intensity and carbon intensity (Payne et al., 2023).

2.2.10 Green Finance And Energy Efficiency

Energy plays a vital part in economic growth because it is a necessary input for economic activity (Yu and He 2020). In this context, some countries' energy consumption has rapidly increased as well (Wang et al. 2015). Increased energy consumption and carbon emission restrictions are the two main obstacles in the global energy transformation stage (Yu et al. 2020). The same problem, namely how to meet the rising energy demand while simultaneously reducing carbon emissions, was covered in British Petroleum's (BP 2019) World Energy Outlook study. According to the International Energy Agency, the largest energy consumers are the residential, transportation, and industrial sectors. Energy efficiency is therefore a major concern, and advancements in it have the potential to drastically reduce energy use and environmental pollution. Several nations have also passed legislation to improve energy efficiency (Locmelis et al. 2020).

A group of scholars, Lobato et al., (2021); Dorfleitner and Grebler, (2022); Yu et al., (2022); Kaiser and Welters, (2019); Lelasi et al., (2018), claimed that green finance instruments can be regarded as a great opportunity to improve energy efficiency projects, while numerous previous studies have not found significant impacts of this type of financing on green projects. The neutrality of the green finance market was observed by Cui et al. (2020) while playing a multi-agent theory game. The key findings highlight how crucially stronger government regulation contributes to the beneficial correlation between green financing and green projects. According to Zhang et al. (2020), there are numerous issues and impediments to energy efficiency in western China, making green funding programmes useless in this region. In a related study, Jin et al. (2021) looked at China's energy efficiency and green funding issues. They came to the conclusion that the market was not ready for green financing at the moment and that it would need to be soon enhanced through formal institutions and financial regulation. Li et al. (2021) discovered using the wavelet power spectrum approach that the green financing market's volatility is a significant factor influencing the market's ability to support green initiatives. Meo and Karim (2021), in contrast to the studies cited above, discovered that green financing has a substantial influence in supporting green projects for the top ten economies that support green finance. In a different study, Khan et al. (2021) examined 26 Asian economies and discovered a favourable connection between the promotion of green projects and green funding. Tu et al. (2021) used wind energy in China as an example to examine the effect of green finance on investments in green energy. The findings emphasised the beneficial effects of green finance on the financial success of wind energy projects. In a recent study, Karim et al. (2022) used an econometric model to emphasise the significance of green finance and its effect on cryptocurrencies. They discovered that the GB market is a practical and secure source of financing during difficult economic times. It is very important to consider the role that green money plays in energy efficiency. Energy initiatives are thought of as being powered by finance, and financial organizations show interest in these projects as well. There has been a significant shift in investment horizons from an Asian perspective, and several Asian nations are pushing green finance. Regarding green finance, it is a method of financing environmental projects. Renewable energy, energy efficiency, and pollution avoidance are a few examples of projects that can be categorized as green, despite the lack of a universal definition, Green bonds are often utilized, especially in energy efficiency initiatives (Azhgaliyeva and Liddle 2020). Numerous empirical studies have been carried out to show how green money affects energy efficiency. For instance, Pavlyk (2020) discovered that green investments improve renewable energy and energy efficiency by using bibliometric analysis. The author has noticed a trend toward more publications on the topics of green finance and energy efficiency. Green finance makes it easier to invest in energy-related projects and promotes green economic growth (Peng and Zheng 2021). This study have identified the promotion effect of green finance on energy efficiency based on the stochastic frontier analysis approach. Two-thirds of the Association of Southeast Asian Nations' (ASEAN) green bonds were used to finance renewable energy and energy efficiency projects, according to Azhgaliyeva et al. (2020), who looked into the ASEAN's issuance of green bonds and green bond policies in order to improve energy efficiency and keep up with the region's accelerated growth in energy availability. According to Taghizadeh-Hesary and Yoshino (2019), who based their claim on theoretical investment models, green credit can help to lower the risks associated with green finance while enhancing profits on green energy projects. Additionally, Zheng et al. (2020) found that the financial industry might support the development of a green economy. These studies have all demonstrated how green money can help people become more energy efficient.

2.2.11 Natural Resource Rent-Energy Efficiency Nexus

The initial acceleration of economic expansion speeds up the production, consumption, and use of materials that cause pollution (Panayotou, 1993). Balsalobre-lorente et al. (2018) estimated the adverse effect of natural resources in environmental pollution. Resource-rich nations produce renewable energy from their resources, which reduces their reliance on energy imports and aids in the prevention of environmental degradation (Balsalobre-lorente et al., 2018). The failure of resource-poor nations, or the "resource curse," is mostly due to energy imports (fossil fuels), which hasten the deterioration of the environment.Additionally, poor environmental quality is caused by overuse of resources brought on by industrialization, deforestation, and mining (Danish et al., 2019). Economic expansion speeds up the extraction of natural resources, which increases waste production (Sarkodie and Strezov, 2019). Hassan et al. (2019) discovered that natural resources increase ecological footprint in Pakistan. Bekun et al. (2019) discovered that natural resource rents contribute to pollution in the European Union's countries. Danish et al. (2019) found inconsistent findings for the impact of natural resources on carbon dioxide emissions for BRICS countries; and Danish (2019) also looked into the impact of global commerce, energy, growth, and environmental pollution and discovered that natural resource rents increase pollution. Ahmed et al., (2020), investigation of the relationship between natural resource rents and ecological footprint in China found that rising natural resource rents result in a growing ecological footprint. The rate of natural resource depletion decreases with the incorporation of sustainable management methods into production and consumption processes, and resources can then be allowed to rebuild. Stronger economic growth depends on the availability of natural resources, but there are drawbacks in the form of environmental deterioration that can be offset by technical innovation (Tawiah et al. 2020).

2.2.12 Urbanization-Energy Efficiency Nexus

Urbanization has emerged as a key driver of economic development, particularly in developing countries. Moving from a rural to an urban area makes financial sense since it offers better living circumstances, easier access to education and the labour market, and cheaper transportation costs. On the other hand, long-term economic growth and higher income levels can be used to achieve technological innovation, strict environmental policy measures, and a structural economic shift away from industries that produce large amounts of pollution and toward services and the knowledge sector, which reduces ecological degradation (Grossman and Krueger, 1991). Conventional wisdom holds that urbanization may increase energy consumption by shifting output to a more energy-intensive end, boosting traffic, and boosting demand for infrastructure (Bai and Imura, 2000). However, due to economies of scale in mass manufacturing, a decline in personal transportation, and the implementation of green building standards, urbanization may have a negative influence on energy (Poumanyvong and Kaneko, 2010). Urbanization and energy use are related, according to research by Al-mulali et al. (2012) that looked at the long-term impact of urbanization on energy use.The effect of urbanization on energy use is therefore uncertain. Al-mulali et al. (2013) are still researching the long-term connection between urbanization and energy use in MENA countries. Only high-income countries have a positive long-term correlation, according to the study. Liu and Xie (2013) observed that the effects of urbanization and industrialization on energy consumption varied between geographical places while controlling for a nation's level of technological and industrial advancement. The role of human activity in the degradation of the environment has increased. The findings have been made by Poumany vong and Kaneko, (2010); Li and Lin, (2015), who demonstrate that urbanization has a positive impact on energy consumption in high-income countries but a negative one in middle-income nations. The relationship between urbanization and energy use has been extensively researched in both theoretical and empirical literature. According to Poumany vong and Kaneko (2010) and Shahbaz et al. (2016), the relationship between urbanization and energy intensity depends on a number of variables, including income level, industrialization and development stage, and population density in urban areas, which is also connected to the type of energy pattern (non-renewable or renewable energies).

Sheng et al. (2017) used a panel of 78 countries for the years 1995–2012 to explore the impact of urbanization on energy efficiency and consumption. According to empirical results from system-GMM, urbanization worsens the prospects for energy efficiency and increases energy consumption. It implies that the process of urbanization has the side effect of energy inefficiency. The study's most popular subtopic is energy consumption connected to urbanization. The previous literature has demonstrated that urbanization increases energy demand for shifting economic activity and industrialization, hence the effect of urbanization on energy efficiency is controversial. Rapid urbanisation in Mexico threatens the foundational elements of economic and social development through influencing the development of industry sectors, housing, and other types of constructions, all of which contribute to environmental deterioration. Rapid urbanisation puts sustainability at risk by spiking energy use and environmental pollution. However, three key aspects of urbanisation have a large impact on environmental pollution: first, the use of residential and industrial energy; second, the building industry's energy use to upgrade infrastructure, public transit, and housing; and third, the clearing of forests for urban growth (Raihan et al, 2022). In addition, increased use of household appliances like air conditioners and water heaters has increased electrical energy consumption, which affects environmental pollution.

2.2.13 Foreign Direct Investments And Energy Efficiency Nexus

The term "FDI" refers to the movement of capital from the home nations of multinational corporations to their host countries, which usually refers to the transfer of knowledge, technology, and management techniques and systems. It is also seen as the primary cause of the decline in energy intensity in emerging market economies. Therefore, it is crucial for policymakers to understand how FDI affects energy intensity. First, a significant body of literature has examined how FDI and energy usage are related. The research on the connection between FDI and energy use is conflicting. On the one hand, FDI has little effect on how much energy is consumed. According to Mielnik and Goldemberg (2002), the introduction of new information technologies into 20 developing nations caused a noticeable reduction in the energy intensity as FDI increased. Sadorsky (2010) examined the effect of FDI on energy consumption in 22 rising nations using a GMM technique. They were unable to identify any meaningful connection between FDI and energy use. The FDI and energy intensity have a strong and adverse association, as found by Elliott et al., (2013) but the relationship varies by region due to regional differences in the capacity to absorb and profit from environmental flows. In order to investigate the connection between foreign direct investment, the use of clean energy, trade openness, carbon emissions, economic growth, and energy demand, Sbia et al., (2014) used the auto-regressive distributed lag bounds testing approach. They discovered that decreasing energy demand is a result of trade openness, carbon emissions, and foreign direct investment. Other than that, FDI has no effect on energy intensity. On the other side, FDI has a beneficial effect on energy usage. First, Robust panel econometric methods were used by Paramati et al, (2016) to examine the impact of FDI on the adoption of clean energy across 20 emerging market economies between 1991 and 2012. The empirical findings showed that FDI significantly increases the consumption of clean energy. Investment in green capital spillovers, which boost FDI flow to the country's overall energy consumption, improves efficiency (Doytch and Narayan, 2016). Second, a substantial body of research has investigated at how FDI affects energy intensity. There is conflicting empirical evidence regarding how FDI affects energy intensity. FDI primarily has an adverse effect on energy intensity. Due to the contradictory empirical findings, the effect of FDI on energy intensity is still up for debate on a global scale. The fact that a lot of the prior studies did not investigate the effect of

FDI on energy intensity under various samples may be the cause of these inconsistent results. Increased renewable energy integration is associated to foreign direct investment (Ergun et al., 2019)

2.2.14 International Trade And Energy Efficiency Nexus

According to Cole (2006), the influence of commerce on energy intensity can be either positive or negative depending on whether the country is importing or exporting the product with a high energy content. Sbia et al., (2014) discovered a relationship between trade openness and energy use. Foreign direct investment (FDI) and commerce both considerably reduce energy intensity, according to Adom (2015). Both linear and nonlinear panel models were used by Rafiq et al., (2016) to get at their conclusion, which is that trade openness considerably lowers both pollutants emissions and energy intensity. Numerous analyses of the connection among trade and energy have been conducted. In Bangladesh, from 1976 to 2014, a time series assessment was done by Pan et al. (2019). They concluded that economic expansion, trade openness, and advances in technology are crucial elements in increasing energy intensity. They also came to the conclusion that trade improves economic activity and aids nations in effectively using their resources. Focusing on the decoupling of energy usage in growth and the incorporation of energy in commerce, Moreau and Vuille (2018) found that in Switzerland, economic expansion substantially offsets energy efficiency, whereas included energy in trade suggests that decoupling is more theoretical than practical. Other researchers have examined the close connection among the structure of exports and energy limitations. Some of these researchers are Farrow et al. (2018) and Meng et al. (2016). From the perspective of industrial technology, some research have empirically looked at the connection among energy efficiency & international trade. According to Lin et al. (2012), manufacturing technique has a significant impact on energy efficiency. Roy and Yasar (2015) confirmed similar findings when they stated that trading increases energy efficiency. However, some research involving energy efficiency and global trade has been done in the instance of China, and these studies can be divided into three categories. The third class, focused on the overall industrial sector whereas Yunfeng & Laike (2010) focused on a specific nation or region. In summary, the literature shows that more commerce leads to increased energy efficiency through increased industrial structure, increased competitiveness, and technological advancements. Additionally, there may be two-way causal relationships between commerce and energy efficiency. Shah W.U.H et al., (2022) studied looks at the connections between G7 economies' energy efficiency, commerce, financial development, and political stability from 1996 to 2015. The Data Envelopment Method is used to calculate these nations' energy efficiency. The Driscoll and Kraay, (1998), approach was used in the study, which discovered that trading is a useful way to boost energy efficiency. The study did, however, make two very important points. First off, innovations resulting from research and development boost commerce but do not promote energy efficiency. Second, while governance benefits trade, it places less of an emphasis on enhancing energy efficiency. Additionally, financial progress improves energy efficiency. The study suggests making a clear connection between integrity in government and energy efficiency; the goal of a healthier planet can't be realised until environmental purity is not the government's main priority. However, there is still much of room for study in this field given the paucity of the literature on the nexuses between commerce and energy efficiency.

2.2.15 Renewable Energy Use And Energy Efficiency Nexus

Fewer research have previously examined the relationships between energy efficiency renewable power output and renewable energy on carbon emissions for a sustainable environment and development (Bayar et al., 2019; Dong et al., 2020; S. Ben Youssef., 2020). As a result, the study makes a contribution by carefully examining the explanatory variables on the use of renewable energy for useful contributions to the literature. In order to achieve significant sustainable growth and advancement in the economy, particularly in emerging economies, efficient energy sources, residential or non-residential patents, and renewable electricity generation are crucial.

In order to ensure an environmentally friendly atmosphere in Nigeria, this study investigates the connections between energy efficiency and renewable energy. Time series data collected from 1981 to 2013 were used to investigate four independent factors (economic growth, energy from fossil fuels use, renewable energy use, and population), carbon dioxide (CO_2) emission serving as a proxy (dependent variable) for the deterioration of the environment. The study also aims to suggest ideas for how the environment may be sustained by using renewable energy sources that result in energy efficiency rather than conventional fossil fuels. In order to determine both long- as well as the short-term duration parameters as well as the path of causation, the vector error correction model's (VECM)-Granger causality test and the autoregressive distributed lags (ARDL) limits testing technique to co-integration were used. The analysis's findings demonstrated that there is co-integration between the variables in both long-run and short-run trajectories. The relationship between renewable energy and environmental quality is supported by the growing harm that using them causes to the environment. The growing pollution caused by the use of fossil fuels necessitates a change in the nation's energy consumption strategy away from traditional fossil fuels and towards renewable energy (Riti, J. S., & Shu, Y., 2016). Verma et al. (2018) investigated the importance of initiatives related to policy for energy efficiency through comparative analysis specifically in three countries, New Zealand, Iceland and Norway. The study stated that efficiency of energy is not good for total energy consumption, while different countries with abundant renewable energy have varied levels of interest in it. The report also made the case that energy efficiency regulations can be created in tandem with new developments in technology. In the same vein, Vujanovi et al. (2019) provided evidence that combining the installation of current technologies with the usage of modern renewable technologies can help to enhance by conserving energy and boost efficiency of energy specifically in buildings and construction. In order to fulfil the Association of South-East Asian Nations' (ASEAN) rapidly expanding energy demand, it is imperative that private capital be mobilised for energy efficiency and renewable energy. Energy efficiency and renewable energy projects were funded with two-thirds of the green bonds that were issued in ASEAN. The study examined ASEAN's green bond regulations and issuance of green bonds. The top three ASEAN nations that issue green bonds, Indonesia, Malaysia, and Singapore, have all had their issuance of environmentally friendly bonds thoroughly examined. The issuing of green bonds is effectively encouraged by environmentally friendly bond policies in ASEAN. This did not, however, imply that green bond laws are successful in encouraging renewable energy and energy-efficient project development in ASEAN. Green investments are not always encouraged in ASEAN as proceeds from environmentally friendly bonds issued in the region might be used to fund projects abroad or refinance previous debts

(Azhgaliyeva, D., Kapoor, A., & Liu, Y., 2020). Energy intensity improvement is a prerequisite for carbon mitigation and decoupling economic growth from energy consumption (Solarin, 2020; Azhgaliyeva et al., 2020). Similarly, the decrease in energy intensity resulting from improved energy efficiency can be reflected in the assessment of carbon intensity through the use of sustainable energy technologies as well as renewable energy sources. It is challenging to quickly switch to renewable energy sources to power the economy due to high initial costs (Qamruzzaman, M. 2022). The role of technology for energy efficiency was examined by Paramati, S.R. et al., (2022). The findings is based on a variety of estimated results that environmental technology significantly increases efficiency by lessons in the intensity of energy while also having a significantly negatively impact on the consumption of total energy. The need to increase energy efficiency is becoming more urgent on a global scale. The call was made for a variety of reasons. The primary cause of this is believed to be the rising cost of fossil fuels because price shocks have a detrimental impact on both the supply as well as the demand of energy (Jahanger, A. et al., 2023). The impact of clean energy sources, income, openness to trade, advancements in technology, and non-renewable energy consumption on the energy intensity for European Union countries was examined by Gyamfi et al., (2023). The analysis used the enhanced mean group, causality, and quantile regression methods. Between 1990 and 2019, panel data of 26 EU countries were used. The results suggest that the factors have equilibrium long-term relationships. However, the analysis showed that commerce, technological advancement, and non-renewable energy usage all increased energy intensity while renewable energy sources and income decreased it. An interactive term analysis reveals that commerce and renewable energy work together to further lessen the detrimental impact of income on energy intensity. According to the findings of the causality analysis, there is a feedback relationship among energy intensity and renewable energy, income, liberalisation of trade, and these variables in addition to the interaction among these variables. The study examined how green finance & renewable energy affect energy efficiency in nonlinear and asymmetric ways. They used the NARDL & 2SLS as methodologies to collect data from 1985 – 2017. The findings show that China (0.61), Brazil (0.55), India (0.53), Indonesia (0.49), Mexico (0.37), and Russia (0.39) have the greatest variations in the growth of green financing in the E-7 area. The country with the highest Gini coefficient in 2019 was Russia (0.57), followed by Turkey. According to empirical studies, the biggest obstacle to achieving green energy production is a lack of corporate and public funding in the energy industry in order to strengthen energy security, improve access to authority, and foster ecologically friendly economic growth. The results show that the implementation of renewable energy as well as energy efficiency in E-7 countries has a bright but precarious future. The study emphasised that in order to realise the financial potential of energy-efficiency improvements in E-7 countries, issues with green financing as well as renewable energy policy limits must be resolved (Wang et al., 2023).

2.2.16 Financial Development Nexus Energy Efficiency Nexus

One of the main factors influencing energy use and carbon emissions is financial development. They are believed to be significantly interconnected to one another. The literature that is now available states that there are two ways that energy consumption might increase. The first is a positive increase brought on by financial progress. Sadorsky (2010), Zaman and Moemen (2017), literature argues that financial growth encourages energy consumption during production and daily life by making it simpler for individuals and enterprises to access finance resources for expensive items. Due to this, both energy used for production and for daily activities increases. In a different study, Sadorsky (2011) used data from the 9-CEEF economies to examine the impact of the financial-energy nexus. . The results demonstrate that financial development (FD), as measured by the ratio of financial institution savings to GDP, bank deposits and holdings to gross domestic product (G stock market capitalization, and liquid liabilities to GDP, increases the demand for energy. Xu (2012), looks on the connection between energy and finance for 29 Chinese provinces from 1999 to 2009. This study used a GMM methodology. The results indicated a favourable correlation between energy use and financial growth. The findings on the connection between financial development and energy use are still in the early stages, claim Shahbaz et al. (2013a). On the other hand, energy is essential to the efficient operation of the financial sector. Development in the financial industry can greatly impact energy consumption, industrial expansion, new infrastructure, and liquidation for investment activities (Islam et al. 2013). Al-mulali and Lee (2013) conducted a similar analysis that uses a panel of GCC nations to examine the long-term relationships between economic growth, trade openness, financial development, urbanisation, and energy consumption. They did this by utilising the Pedroni cointegration approach. The study's conclusions showed that economic growth, urbanisation, trade openness, and financial development all had a favourable impact on energy usage. An further study came to the similar conclusion that population expansion, financial development, and economic growth are what influence energy use. In Malaysia, the feedback effect between economic growth and energy use is also apparent. Granger's energy usage is a short-term result of financial growth (Tang and Tan 2014). Additionally, there is a two-way causal relationship between urbanisation and financial development, energy consumption and growth, trade openness and economic growth. Additionally, both urbanisation and financial development are found to have a one-way causal link with energy use. From 1971 to 2009, Ilam studies the impact of financial growth on energy use (Tang and Tan 2014). The results showed that energy and financial development have a causal relationship that is reciprocal. Chang intends for financial development to provide up prospects for the expansion of the renewable energy sector by supplying more funding for creative businesses (Chang 2015a, b). Additionally, FDI may result in increased technological innovation and a decrease in energy use.

Furuoka (2015) also used a panel test called cointegration to investigate the relationship between finance and energy use in Asia from 1980 to 2012. The result supports the long-term link between finances and energy use. Another study (Kumar et al. 2016) looked at the long-term correlation between energy and finance in Pakistan from 1972 to 2012. The results of this empirical study showed that financial development has a significant favourable impact on energy use. For a panel of 22 developing nations from 1990 to 2006, Researcher observed a direct correlation between energy and financial development (Shahbaz et al. 2016). The study's findings show a strong correlation between the explanatory factors. The results of the study looked at whether there was a one-way causal relationship between financial development and energy demand. Kahouli also noted that as financial development picks up, energy consumption increases, which negatively influences Israel's actual output growth (Kahouli 2017). The negative correlation between financial development and energy usage is the second inhibitory effect (Topcu and Payne 2017; Gómez and Rodrguez 2019). Additionally, a one-way causal relationship is seen between energy usage and financial progress. As a result, the increase in energy consumption could promote Asia's financial prosperity. Additionally, it demonstrates how the use of energy in BRICS nations is decreased by financial sector expansion (Alsaman et al. 2017). According to a different study by Fan et al., (2017), greater energy efficiency can reduce energy consumption and boost China's financial development. Despite the importance of other economic factors, financial development can also positively influence and bring about a number of changes within an economy. For instance, it can help with the simple availability of financial capital, encourage international investments, make energy-efficient appliances more widely available, reduce financial risks, lower borrowing costs, and improve the transparency of business dealings between borrowers and lenders. With fixed investments made by firms in various nations, any such economic activity stimulation can have an impact on energy consumption (Saud et al. 2018). The establishment of energy-efficient initiatives can be funded by the financial development.

Shahbaz et al. (2018) investigate the Tunisia's energy-finance nexus from 1971 to 2008. For data analysis, the ARDL and Johansen cointegration tests were used. The findings show that energy use and finances have a long-term relationship. Additionally, the two variables' bidirectional causal link was also found. Using the Juselius and Johansen co-integration method, a similar study examines whether there is a long-run relationship between FDI, comparative prices, growth in the economy, FD, and consumption of energy. According to this study, there is a one-way causal relationship between financial development and economic expansion as well as a bidirectional relationship between growth and energy use. Saudi Arabia has more recently studied the relationship between energy and finance during 1971–2011, (Anser et al. 2020).

CHAPTER THREE

RESEARCH METHODOLOGY

In the section on research methodology for this study, it is explained how the relationships among independent variables (such as green finance, FDI, natural resource rent, international trade, urbanization, as well as economic growth), mediating variables (such as renewable energy), moderating variables (such as financial development), and dependent variables (such as environmental quality as well as energy efficiency) were examined. The chosen approach aims to offer a structured and exacting framework for gathering, analysing, and interpreting data. The study tries to identify quantitative relationships between the pertinent variables and produce empirical evidence using a method known as quantitative research. In order to respond to the research issues and fulfil the study objectives, the methodology, data collection procedures, sample plan, and data analysis tools are all described in this part.

3.1 Research Philosophy

A researcher's research philosophy consists of their fundamental beliefs, assumptions, and guiding principles (Saunders et al., 2007). This philosophy can guide their approach to conducting research and developing new information. It provides a framework for comprehending the nature of reality, the researcher's function, and the methods used to investigate business research issues. The origin, nature, and growth of knowledge are all topics in research philosophy (Bajpai, N. 2011). Research philosophy is just an opinion on how information about a phenomenon should be gathered, processed, and applied. There are four main research philosophies that fall under the umbrella of business studies in particular: Pragmatism, Positivism, Realism and The interpretivist school of thought.

3.1.1 Pragmatism

The study philosophy of pragmatics recognizes notions as relevant only if they facilitate action. A pragmatic approach "acknowledges that there are many different ways to interpret the world and conduct research, that no single point of view can ever give the entire picture, and that there may be multiple realities."

3.1.2 Positivism

Positivism will be used in this study. It is reliant on quantitative observations that result in statistical investigations. For many years, it has dominated the fields of business and management research. As a philosophy, positivism is said to be in line with the empiricist theory that knowledge derives from human experience. The world is seen as consisting of discrete, observable elements and events that interact in an observable, predictable, and regular way. This is known as an atomistic, ontological perspective. According to Crowther and Lancaster (2008), positivist research typically use a logical methodology. Positivism is a suitable philosophy for this study, as positivism concentrates on the objective of measurable reality. The purpose of the study is to examine the causal link between green finance and environmental quality employing secondary data. It permits a quantitative as well as systematic examination of the available data to determine the causal relationships between these variables.

3.2 Research Approach

Deductive reasoning is defined as moving from the specific to the universal. If a theory or case study seems to imply a causal relationship or correlation, it may be true in many instances. A deductive design may be used to check whether this relationship or link held true under more broad conditions (Gulati, PM, 2009). Hypotheses that can be derived from the theory's propositions can be used to explain the deductive process. In other words, the deductive method focuses on drawing inferences from premises or assertions. In a deductive approach, "developing a hypothesis (or hypotheses) based on existing theory, and then designing a research strategy to test the hypothesis" are the main goals (Wilson, J., 2010). While induction starts with data and looks for patterns within them, deduction starts with an expected pattern that is "tested against observations" (Babbie, 2010). The deductive research method investigates a well-known hypothesis or phenomena and determines whether it holds true under certain conditions. "The deductive approach follows the path of logic most closely," it has been said. The argument proceeds from a theory to a novel hypothesis. This hypothesis is tested by exposing it to observations, which either confirm or refute the hypothesis"(Snieder, R. & Larner, K. 2009).

Examining the causal relationship between green finance and environmental quality, this study employs secondary data best adapted for the deductive method of theory development to examine the relationship between green finance and environmental quality. This methodology involves formulating hypotheses based on existing literature and verifying them through the analysis of available secondary data. This study guarantees a systematic and structured examination of the proposed relationship by employing a deductive methodology, thereby contributing to the validation or refinement of existing theories.

3.3 Research Design

Similar to the research approach, research design is defined differently in several textbooks. Some authors view the choice between qualitative and quantitative research approaches as the research design. Others contend that study design relates to the selection of particular data gathering and processing techniques. The most accurate definition of the phrase for research design appears to be a master plan for carrying out a research activity. The two types of research designs are exploratory and conclusive. Exploratory research only seeks to examine several facets of the research field, as suggested by its name. Exploratory research does not seek to address research issues in a definitive manner. In certain cases, but not necessarily substantially, the researcher may even alter the course of the study in light of fresh information discovered during the course of the investigation. Contrarily, conclusive research produces results that can actually aid in decision-making. Exploratory research, as its name suggests, does not seek to provide complete answers to problems that already exist; rather, it seeks to only investigate the research questions. This kind of study is typically done to investigate a topic that hasn't yet been precisely defined. Exploratory research is done to identify the problem's nature; it is not meant to offer proof that the problem exists, but rather to give us a better understanding of it. Exploratory research design only explores the study issue in various degrees of depth rather than attempting to offer definitive solutions to the research questions. According to a statement made previously, exploratory study serves as the foundation for more conclusive research. Even the selection of the research design, sample strategy, and data collection technique might be aided by it (Singh, K., 2007). Exploratory research "tends to focus on novel issues for which little or no prior research has been conducted" (Saunders, M., Lewis, P. & Thornhill, A. 2012). As the name suggests, conclusive research design is used to produce results that are practically useful in drawing conclusions or making decisions. Research goals and data needs must be outlined clearly for this type of study. Conclusive research' findings typically have a specific purpose. Exploratory study results can be validated and quantified using conclusive research design. A conclusive study strategy typically uses quantitative techniques for data collection and analysis. Furthermore, decisive investigations frequently have a deductive structure, and their study goals are accomplished through testing hypotheses.

Conclusive research is more likely to apply statistical tests, sophisticated analytical procedures, and bigger sample sizes than exploratory investigations, it should be mentioned. Research that is conclusive is more likely to use quantitative methods than qualitative ones (Nargundkar, 2008). By using a dependable research instrument, conclusive research aids in presenting a trustworthy or representative image of the population. Descriptive research and causal research are the two subcategories of conclusive research design. The following categories of descriptive research can be used to further categorise some functions or properties of phenomena: Study types include case study, case series, cross-sectional, longitudinal, and retrospective. Contrarily, causal research examines the connections between causes and effects. Experimental and quasi-experimental studies are two widely used research techniques for causal studies.

Explanatory study, sometimes referred to as causal research, is carried out to determine the scope and type of cause-and-effect interactions. It is possible to do causal study to evaluate how particular changes would affect prevailing norms, various processes, etc. In order to understand the patterns of interactions between variables, causal investigations concentrate on an analysis of a given circumstance or issue. The most common primary data collection techniques used in studies with causal study design are experiments.

This research falls under explanatory research because it uses secondary data to provide causal explanations for the relationship between green finance and environmental pollution. This study will investigate and explain, through quantitative analysis, how changes in green finance may impact the outcomes of climate change. Contributing to a greater comprehension of this causal relationship, this study offers policymakers, practitioners, and researchers valuable insights for addressing climate change challenges.

3.4 Nature of Study

When conducting research, it is essential for a researcher to be specific when selecting a research type, as this decision can have a significant impact on the results and the degree of importance of the research model (Kumar, 2018). According to (Sekaran, 2003), qualitative and quantitative studies are the two primary types of inquiry. In contrast, Sekaran's classification, Creswell & Poth, (2016), includes qualitative, hybrid, and quantitative research methods. Creswell explains that there are less rigorous (quasi) experiments and correlational analyses within quantitative strategies. In addition, he differentiates between two sub-methods within quantitative strategies: experiments and surveys. Using questionnaires as well as structured interviews with a sample population, surveys capture data about a particular topic.

This study employs a quantitative research methodology to examine the relationship between green finance and sustainable development using secondary numerical data. Through the systematic accumulation and examination of numerical data, statistical methods will be utilized to investigate the strength and significance of this relationship. This strategy enables precise and quantifiable outcomes, facilitating decision-making and policy formulation based on evidence.

3.5 Variables

Green finance, urbanisation, natural resource rent, foreign direct investment, economic growth, and international trade are all considered independent variables in this study. Energy efficiency and environmental pollution are considered dependent variables. Financial development serves as a moderator and Renewable energy use serves as a mediator. These variables taken as control variables for this study. Labour force, Merchandise trade, Infrastructure, fixed capital, gross savings.

3.5.1 Dependent Variables

The Dependent variables are environmental pollution and Energy Efficiency. The majority of recent research employ carbon dioxide emissions as an outcome variable in environmental evaluation and as a stand-in for environmental quality (Kartal M.T et al., 2022; Pata, U. K., & Kartal, M. T. 2023). A new environmental measure, such as the load-carrying capacity factor, which takes into account a country's biocapacity as well as ecological footprint (EF), is preferred by some current studies. Thus, it can be said that there is now a larger body of research on the quality of the environment and the factors that influence it. environmental pollution will be used in this study to measure environmental quality.

The second dependent variable Energy Efficiency. Recent research employ energy intensity as an indicator for outcome variable energy efficiency (Quang, P. T., & Thao, D. P. 2022). This study will measure energy efficiency with energy intensity.

3.5.2 Independent Variables

Li and Gan (2021) investigate the effects of green finance on the ecological environment, creating a comprehensive index that combines both positive and negative indicators, such as wastewater discharge, desertification, and industrial waste investment. However, only a small percentage of researchers employ environmental protection products (Li et al., 2022). This study uses products that protect the environment to measure green financing. The OECD Statistics are used to compile the Green Finance data (Environmental protection goods by residence). The data for the other variables was only available for paid subscribers.

In order to measure FDI inflow, a number of studies, including Owusu-Nantwi and Erickson (2019) and Kurul and Yalta (2017), have been conducted for various locations and time periods. Inflows of foreign direct investment as a share of GDP are known as FDI (Khan, H., Weili, L., & Khan, I. 2022). In the literature, there are various indicators of natural resource rent. Some studies (Medase et al., 2023) measure natural resource rent using the sum of oil, natural gas, coal, and forest rent percentages of GDP; other studies (Tajuddin et al., 2023) measure natural resource rent using the income via natural resources as a proportion of GDP; and still other studies (Li et al., 2022) measure natural resource rent using the Natural resource rent percentages of GDP (Wang et al., 2023; Sha, 2023). Urbanisation is quantified in literature by the proportion of people who live in cities to all people (Fang et al., 2020; Majeed et al., 2020; Li et al., 2022). This indicator of urbanisation was also employed in this study because it is frequently cited in the literature. Economic growth. Some studies, Godil et al., (2020); Shoaib et al., (2020), use the percentage of annual growth in per capita GDP to quantify economic growth. Economic growth is measured in this study as a percentage annual growth.

Various indicators are used in the literature to measure international trade. According to certain analyses, Nathaniel et al., (2021), the GDP is measured as the total of imports and exports. Some research (S. Amin et al., 2021; Ojekemi et al., 2022) use import and export made indexes to measure international commerce. Indicator import and export made indexes are used in this study's PCA technique to measure global commerce. The second model in this study looks at how increasing the use of renewable energy can increase financial sustainability. The World Bank Indicators (WDI) are where the information on renewable energy use is sourced.

3.5.3 Control Variables

A demographic subdivision of the population is the labour force. Earlier research, including that by Joshua et al. (2020); Joshua, Alola & Salami, (2020), use population to examine the FDI-growth theory in the context of a country (Nigeria) were also used by Joshua et al. (2020), to support that population is the potential variable in establishing a link between FDI-GDP in the country (South Africa). Therefore, labour force structures are defined by population patterns. Trade openness used as control in the literature. Some studies measure trade openness by sum of import and export percentage of GDP (Fang et al., 2020; Law et al., 2018). This study measure trade openness with a Percentage of merchandise exports. The control variable of gross savings was also acquired from World Bank data. To reduce cross-country variances, gross savings were scaled by GDP (Chakraborty, R., & Abraham, R. 2021). According to Aschauer, (1998), infrastructure is necessary for a healthy lifestyle of public. For example, broad roads decrease accident's ratio and safety for public, a system of water supply lowers the illness rates, and waste control enhances environmental health. In present day, mobile is a crucial industry for fostering global trade, FDI, and economic expansion. In their research of the application of SDPs, (Grundey, 2008; Burinskiene and Rudzkiene, 2009) identify infrastructure development as one of the most critical elements of long-term strategic planning for the nation's socioeconomic and spatial sustainability. Infrastructure was determined by the number of mobile subscriptions per 100 persons (Nchake, M. A., & Shuaibu, M. 2022).

3.5.4 Mediating Variable

The mediating variable is usage of renewable energy. Diverse scholars employed a variety of variables to measure renewable energy. According to several researchers (Croutzet et al., 2021; L. Zhang et al., 2021; Zhou et al., 2022), they use bioenergy, wind energy, solar energy, hydropower, and water power. Few studies use the percentage of total energy consumption that is made up of renewable energy (Dzankar Zoaka et al., 2022; D. Zhang, Mohsin et al., 2021). Because this study is concentrating on the entire consumption of renewable energy rather than the various types of renewable energy sources, it will use the renewable energy consumption percentage of total energy consumption.

3.5.5 Moderating Variable

The moderating variable is Financial development. There are various financial development indicators in the literature. Some researchers make use of the IMF's financial development index (Chandio et al., 2022; Pata et al., 2023). Some studies employ Domestic Credit for the Financial sector as a proportion of GDP (Godil et al., 2020a; Jinqiao et al., 2022a; Zameer et al., 2020). Domestic Credits to the Financial Sector as a Percentage of GDP is used to measure the development of finance in this study. This study employs this indicator as in this study, the Author examines how domestic financial development enhances the adoption of renewable energy and contributes to environmental sustainability. The Financial Development Data is derived from the World Bank's World Development Indicators (WDI).

Table 3.1 List of Variables

Dependent Variables	**Notation**	**Indicator**	**Database**
Environmental Pollution	EVP	CO_2 Emissions	WDI
Energy Efficiency	EE	Energy intensity	WDI
Independent Variables			
Green Finance	GFN	Environmental Protection Product by Resident	OECD
Natural Resource Rent	NRR	Natural resource Rent	WDI
Urbanization	URB	Urban population % of total	WDI
Economic Growth	EG	% Annual Growth of GDP	WDI
International Trade	IT	Exports, Imports	WDI
Foreign Direct Investment	FDI	FDI net Inflows	WDI
Control Variables			
Infrastructure	INF	number of mobile subscriptions per 100 persons	WDI
Gross savings	GNS	% of GDP	WDI
Labour force	LF	Total labour force of populations	WDI
Merchandise Trade	MT	% Merchandise Export	WDI
Mediating Variable			
Renewable Energy use	REU	Renewable energy consumption % total energy	WDI
Moderating Variable			
Financial Development	FD	Domestic to the Financial sector	WDI

3.6 Data, Sampling, Measurement Units And Limitations

3.6.1 Data

This investigation utilized secondary data collected from multiple sources. The data on green finance came from the OECD website, whereas the data on other variables came from the World Bank Indicators. Nonetheless, it is crucial to observe that the availability of data on green finance restricted the analysis to the years 1999 to 2019. Consideration was given to these data sources and limitations to provide a comprehensive of the research's scope and timeframe. The study about modelling aims to comprehend how REU mediates the effects of REU, GFN, EGC, NRR, IT, and URB on environmental degradation and energy efficiency while examining the moderation of Financial development by employing a two-stage moderated mediation model in the particular case of 79 countries. The availability of annual data was the main basis considered to choose the sample period and nations for the entire study. The study use quantitative approach and secondary data covering the years 1999-2019. The dataset for the variables is taken from the World Bank's, (2022) and OECD, (2022). The following factors are included in the data: inflow of FDI (% of GDP), and REU (percentage of energy consumption), while environmental pollution were calculated using tonnes of CO_2 emission per person. Financial development measured by Domestic to the Financial sector. NRR (% of GDP), URB was calculated against the total urban population (% of total population). The proportion of GDP that is exported and imported was used to gauge International trade, while the share of GDP that is fixed capital formation was used to gauge capital stock. Total labour force of populations was used to calculate labour force. Infrastructure was determined by the number of mobile subscriptions per 100 persons, while saving was calculated as a (% of GDP). Goods in trade was calculated as the amount of exports and imports of goods, GDP growth (constant 2015 US$), energy intensity (MJ/$2017 PPP GDP), and green finance (Environmental protection products by residents) are some of the factors that are taken into consideration.

3.6.2 Sampling

Population refers to the study's intended group or entities. It is the larger population from which the data is collected or obtained. This study's objective is to examine global population dynamics. Although all nations are included in the scope of the study, 79 nations were chosen as a representative sample because they had access to reliable and comprehensive data. The Organization for Economic Cooperation and Development (OECD), and World Development Indicators (WDI) are only a few of the reputable and trustworthy data sources utilized in this study. Since this period provides the most reliable and comprehensive data for the important variables under consideration, the analysis spans the 21-year period between 1999 and 2019. This study acknowledges the limitations imposed by the lack of data by focusing on a selection of countries for which statistics are available, while endeavoring to provide pertinent insights about global population trends and patterns. The sample size of this study is calculated by this formula:

$$\frac{\frac{N * [Z^2 * p * (1-p)}{e^2}}{\frac{N-1+[Z^2 * p * (1-p)}{e^2}} + \dots$$

Sampling can be defined as the selection of individuals from a population for an investigation based on a specific set of criteria. Because many populations of interest are too large to deal with directly, several statistical sampling procedures have been developed to collect samples from larger populations. Convenience sampling is a non-probabilistic or non-random sampling technique in which respondents are selected and included in the study based on predetermined criteria, such as ease of access, geographic proximity, availability at a specified time, or willingness to participate (Dornyei & Griffee, 2010). This study obtains data based on the availability of data, so it employs the convenience sampling technique.

3.7 Theoretical Framework and Research Hypotheses

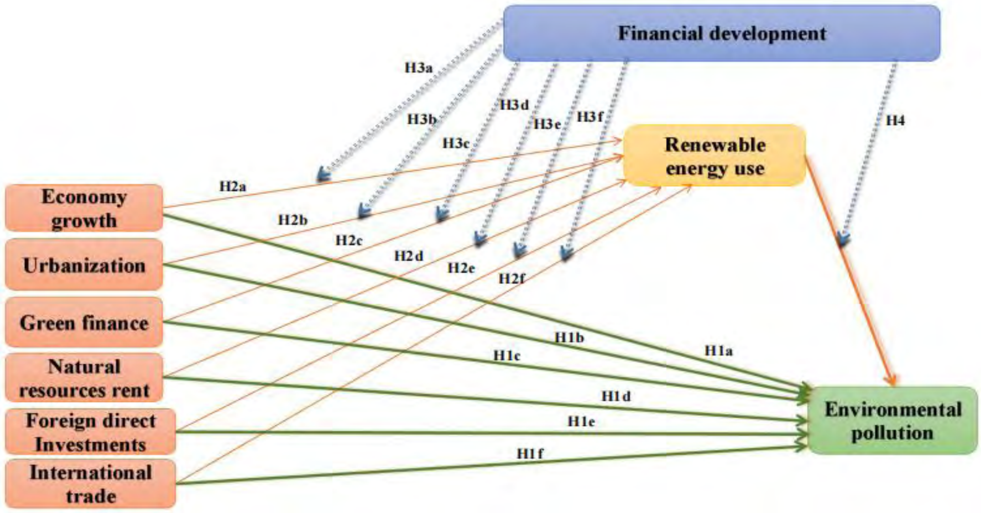
An efficient, effective, and well-organized financial sector can contribute to a country's economic growth.When compared to nations with inefficient banking and stock market structures, a country with sophisticated banks and stock markets grows quickly (King and Levine 1993). The demand for financial resources by the company also rises as a result of a growth in consumer demands and an infusion of new technology, which eventually fuels the demand for financial institutions, particularly banks. Historically, bank funding have always been allocated to the most lucrative projects without taking the environment into account. According to Beck et al., (2000), the financial sector acts as a catalyst for economic growth in a nation by providing the capital required for development operations. Levine, (1997), asserts that the development of the banking industry and the effectiveness of the stock markets directly affect the rate of economic growth in a nation. Complete decoupling of economic growth and environmental pollution is required by the emergence of green growth. Green financing has been increasingly popular in line with the concept of sustainable development, which has encouraged banks and other financial sectors to allocate funding to environmentally friendly, resource-efficient activities.

Additionally, a rise in carbon dioxide and other greenhouse gases may result from the widespread use of these alternative energy sources (Hao et al., 2021). The degradation of the ecosystem and the increase in carbon dioxide emissions from various non-renewable energy sources have exacerbated the issue of climate change (Imtiaz & Shah, 2008). It is generally agreed that the environmental impact of renewable energy is significantly less than that of fossil fuels like petroleum, gasoline, and charcoal when compared to that of carbon dioxide emissions across the corpus of scholarly study on these topics. The results of the most current studies predict that REU will have a negative effect on the amount of carbon emissions.

This study's Research Hypotheses section examines the relationships between the variables that are independent (green finance, natural resource rent, FDI, urbanization, economic growth, and international trade) and the dependent variables (environmental quality and energy efficiency). On the basis of extant theoretical frameworks, empirical evidence, and research objectives, these hypotheses are formulated. They specify the anticipated trajectory and significance of the connections between variables. This study seeks to provide a clear and structured framework for testing proposed associations and assessing the impact of independent variables on dependent variables by formulating research hypotheses. These hypotheses will be examined through empirical research and statistical tests to obtain insight into the factors that affect environmental quality and energy efficiency.

3.7.1 Theoretical framework of Model 1

Figure 3.1 Conceptual Model: Both Side Moderated Mediation of FD.



(Source: Adapted from Tarek Bel Had, 2021)

In Fig 3.1, which depicts the study conceptual model of moderated mediation, these conditional impacts of GFN, FDI, URB, EG, IT and NRR on EVP through REU are illustrated. Following are the main and sub-hypothesis for Model 1.

3.7.2 Hypothesis of Model 1

H$_{0a}$: Economic growth, urbanization, natural resource rent, international trade, green finance and FDI does not affect environmental pollution.

H1a: Economic growth has impact on environmental pollution.

H1b Urbanization has impact on environmental pollution.

H1c Green finance has impact on environmental pollution.

H1d Total natural resources have impact on environmental pollution.

H1e FDI has impact on environmental pollution.

H1f International trade has impact on environmental pollution.

H_{0b}: Economic growth, urbanization, natural resource rent, international trade, green finance and FDI with renewable energy use does not affect environmental pollution.

H2a: Renewable energy use mediates the relationship between economic growth on environmental pollution.

H2b Renewable energy use mediates the relationship between Urbanization on environmental pollution.

H2c Renewable energy use mediates the relationship between green finance on environmental pollution.

H2d Renewable energy use mediates the relationship between NRR on environmental pollution.

H2e Renewable energy use mediates the relationship between FDI on environmental pollution.

H2f Renewable energy use mediates the relationship between international trade on environmental pollution.

H_{0c}: Economic growth, urbanization, natural resource rent, international trade, green finance and FDI on renewable energy use does not moderate by FD.

H3a The effect of economic growth on renewable energy use is moderated by FD.

H3b The effect of urbanization on renewable energy use is moderated by FD.

H3c The effect of green finance on renewable energy use is moderated by FD.

H3d The effect of NRR on renewable energy use is moderated by FD.

H3e The effect of FDI on renewable energy use is moderated by FD.

H3f The effects of IT on renewable energy use is moderated by FD.

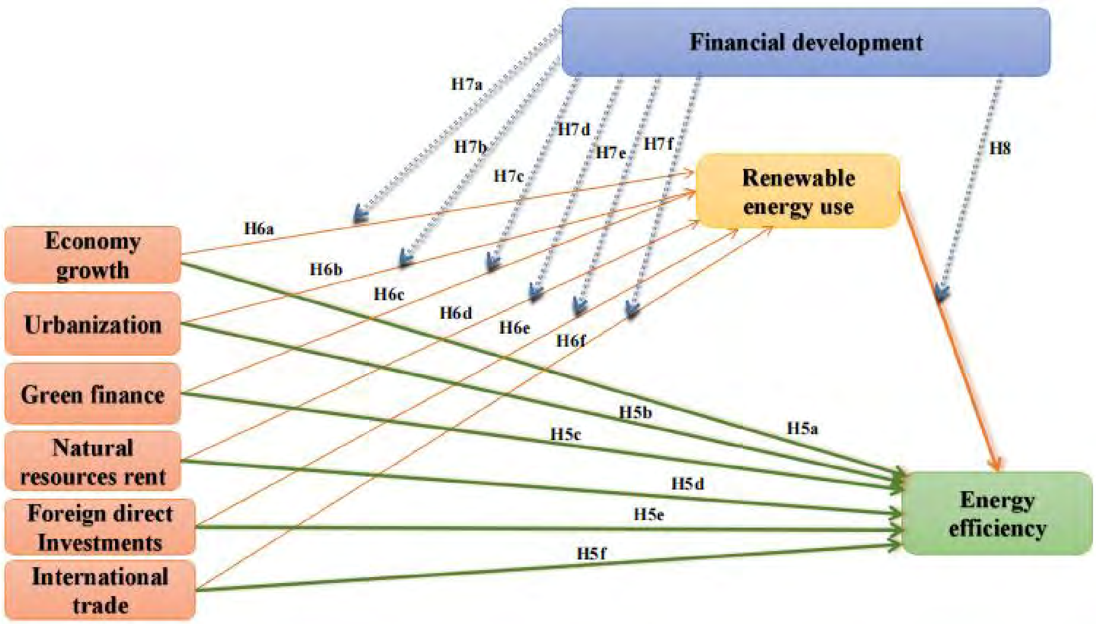
H_{0d}: FD does not moderate the effect of renewable energy use on environmental pollution.

H4 FD moderates the effects of renewable energy use on environmental pollution.

3.7.3 Theoretical Framework of Model 2

In Fig 3.2, which depicts our conceptual model of moderated mediation, these conditional impacts of GFN, FDI, URB, EG, IT and NRR on Energy Efficiency through REU are illustrated.

Figure 3.2 Conceptual model: both side moderated mediation of Financial development.



(Source: Adapted from Tarek Bel Had, 2021)

3.7.4 Hypothesis of Model 2

H_{0a}: Economic growth, urbanization, natural resource rent, international trade, green finance and FDI have no impact on energy efficiency.

H5a Economic growth has impact on energy efficiency.

H5b Urbanization has impact on energy efficiency.

H5c Green finance has impact on energy efficiency.

H5d Total natural resources has impact on energy efficiency.

H5e FDI has a positive impact on energy efficiency.

H5f International Trade has a positive impact on energy efficiency.

H_{0b}: Economic growth, urbanization, natural resource rent, international trade, green finance and FDI with REU does not affect energy efficiency.

H6a Renewable energy use mediates the relationship between economic growth on energy efficiency.

H6b Renewable energy use mediates the relationship between urbanization on energy efficiency.

H6c Renewable energy use mediates the relationship between green finance on energy efficiency.

H6d Renewable energy use mediates the relationship between NRR on energy efficiency.

H6e Renewable energy use mediates the relationship between FDI on energy efficiency.

H6f Renewable energy use mediates the relationship between international trade on energy efficiency.

H_{0c}: Economic growth, urbanization, natural resource rent, international trade, green finance and FDI on renewable energy use does not moderate by FD.

H7a The effect of economic growth on renewable energy use is moderated by FD.

H7b The effect of urbanization on renewable energy use is moderated by FD.

H7c The effect of green finance on renewable energy use is moderated by FD.

H7d The effect of NRR on renewable energy use is moderated by FD.

H7e The effect of FDI on renewable energy use is moderated by FD.

H7f The effects of IT on renewable energy use is moderated by FD.

H_{0d}: FD does not moderate the effects of renewable energy use on energy efficiency.

H8 FD moderate the effects of renewable energy use on energy efficiency.

3.8 Empirical Model

3.8.1 Model 1-Environmental Pollution

Determine the conditional effects of urbanization, green financing, economic growth, foreign direct inflows, international trade, and natural resources on environmental pollution through REU is the goal of this first stage of moderated mediation. In our initial step, Researcher assume that the relationship between urbanization, green financing, economic growth, foreign direct inflows, international trade, natural resources, and REU is such that these effects are moderated by financial development.

$$\mathrm{EVP_{it}} = \mathrm{f(GFN_{it}, NRR_{it}, FDI_{it}, IT_{it}, EG_{it}, URB_{it})}$$

$$\mathrm{EVP_{it}} = \beta_0 + \beta_1\mathrm{GFN_{it}} + \beta_2\mathrm{NRR_{it}} + \beta_3\mathrm{FDI_{it}} + \beta_4\mathrm{IT_{it}} + \beta_5\mathrm{EG_{it}} + \beta_6\mathrm{URB_{it}} + \mu_{\mathrm{it}} \quad \text{......} (1)$$

$$\mathrm{EVP_{it}} = \beta_0 + \beta_1\mathrm{GFN_{it}} + \beta_2\mathrm{NRR_{it}} + \beta_3\mathrm{FDI_{it}} + \beta_4\mathrm{IT_{it}} + \beta_5\mathrm{EG_{it}} + \beta_6\mathrm{URB_{it}} + MV_{it}\partial_1 REU_{it} + MO_{it}\partial_1 FD_{it} \quad \text{......} (2)$$

$$\mathrm{EVP_{it}} = \beta_0 + \beta_1\mathrm{GFN_{it}} + \beta_2\mathrm{NRR_{it}} + \beta_3\mathrm{FDI_{it}} + \beta_4\mathrm{IT_{it}} + \beta_5\mathrm{EG_{it}} + \beta_6\mathrm{URB_{it}} + MV_{it}\partial_1 REU_{it} + MO_{it}\partial_1 FD_{it} + C_1 MT_{it} + C_2 LF_{it} + C_3 GNS_{it} + C_4 INF_{it} + \mu_{\mathrm{it}} \quad \text{......} (3)$$

Where I and t stand for individual nations and eras, respectively. The erroneous term is (µit). The variables GFN stands for green financing, FDI for foreign direct investment flows, URB for urbanization, EG for economic growth, IT for international trade, NRR natural resources rent, FD for Financial development, REU for usage of renewable energy sources and Energy Efficiency in Equations (1) and (2).

The set of control variables in Equation (3) is represented by the variables LF reflect the labour force, GNS for gross savings, INF used for Infrastructure, and MT for trade in goods.

3.8.2 Model 2-Energy Efficiency

Determine the conditional effects of urbanization, green financing, economic growth, foreign direct inflows, international trade, and rent from natural resources on

Energy efficiency through REU is the goal of this first stage of moderated mediation. In our initial step, Researcher assume that the relationship between urbanization, green financing, economic growth, foreign direct inflows, international trade, natural resources, and REU is such that these effects are moderated by financial development.

$$EE_{it} = f(GFN_{it}, NRR_{it}, FDI_{it}, IT_{it}, EG_{it}, URB_{it})$$

$$EE_{it} = \beta_0 + \beta_1 GFN_{it} + \beta_2 NRR_{it} + \beta_3 FDI_{it} + \beta_4 IT_{it} + \beta_5 EG_{it} + \beta_6 URB_{it} + \mu_{it} \ldots\ldots (4)$$

$$EE_{it} = \beta_0 + \beta_1 GFN_{it} + \beta_2 NRR_{it} + \beta_3 FDI_{it} + \beta_4 IT_{it} + \beta_5 EG_{it} + \beta_6 URB_{it} + MV_{it}\partial_1 REU_{it} + MO_{it}\partial_1 FD_{it} \ldots\ldots (5)$$

$$EE_{it} = \beta_0 + \beta_1 GFN_{it} + \beta_2 NRR_{it} + \beta_3 FDI_{it} + \beta_4 IT_{it} + \beta_5 EG_{it} + \beta_6 URB_{it} + MV_{it}\partial_1 REU_{it} + MO_{it}\partial_1 FD_{it} + C_1 MT_{it} + C_2 LF_{it} + C_3 GNS_{it} + C_4 INF_{it} + \mu_{it} \ldots\ldots (6)$$

Where I and t stand for individual nations and eras, respectively. The erroneous term is (μit). The variables GFN stands for green financing, FDI for foreign direct investment flows, URB for urbanization, EG for economic growth, IT for international trade, NRR for natural resources rent, FD for Financial development, REU for usage of renewable energy sources and Energy Efficiency in Equations (4) and (5).

The set of control variables in Equation (6) is represented by the variables LF reflect the labour force, GNS for gross savings, INF used for Infrastructure and MT for trade in goods

3.9 Descriptive Statistics

3.9.1 Descriptive Statistics of Model 1

The table provides descriptive statistics for a number of variables within the dataset. Each observation's identification number or code is represented by the "ID" variable. There are 1659 observations in total, ranging from 1 to 79. The data set spans the years 1999 to 2019, with 2009 as the median year. The standard deviation of 6.057 indicates that the years represented in the dataset are variable. environmental pollution emissions. The mean value is 2,408, and the standard deviation is 0.142. The range of variation in environmental pollution is indicated by a minimum value of 1.975 and a maximum value of 2.784. The variable "IT" pertains to a measure of international trade. The mean value is 0.744, and the standard deviation is 0.351. Minimum value of 0.012 and maximum value of 2.388 indicate the range of sustainable quality variation in international trade. NRR has an average value of 1.494 and a standard deviation that is relatively high at 1.526. The minimum value of -2.207 and the utmost value of 7.437 indicate that natural resource rent varies significantly. The average value of economic growth 2.185, and the standard deviation is only 0.267. The range between the minimum value of -0.396 and the utmost value of 2.454 indicates the extent of environmental conservation efforts. The mean value of URB 4.126, and the standard deviation is 0.425%. The range of variation in urbanization levels is denoted by the minimum value of 2.203 and the utmost value of 4.605. Only 1648 observations are available for this variable. The mean value of FDI is 1.013, and the standard deviation is 1.352. The range of variation in foreign direct investment is indicated by the minimum value of -6.524 and maximum value of 6.107. The mean value of green finance is 2,373 and the standard deviation is 0.552. The range of variation in green finance is denoted by a minimum value of -0.174 and a maximum value of 4.528. Renewable energy consumption has an average value of 2.365 and a standard deviation that is relatively high at 1.526. Minimum value of -4,665 and maximum value of 4,514 indicate the range of renewable energy usage variation. The mean value of financial development is 4.014, and the standard deviation is 0.727. Minimum value of -1,681 and maximum value of 5,542 indicate the range of financial development variation. Participation in the labour force is denoted by the variable "LF" Its mean value is 15.856 and its standard deviation is 1.586. Minimum value of 11.941 and maximum value of 20.5 indicate the range of labour force participation variation. An economic indicator associated with gross national savings or economic growth. The mean value is 3.081, and the standard deviation is 0.461. The range of variation in economic growth or gross national savings is denoted by the minimal value of -0.42 and the maximum value of 4.203. The "INF" variable represents infrastructure. The mean value is 4.148, and the standard deviation is 1.059. Minimum value of 0.013 and maximum value of 5.36 indicate the range of inflationary variation. The "MT" variable represents the merchandise trade. The mean value is 4.07, and the standard deviation is 0.541. Minimum value of 2.753, maximum value of 5.839 indicate variation in economic development or modernization.

Table 3.2 Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
ID	1659	40	22.81	1	79
Years	1659	2009	6.057	1999	2019
EVP	1659	2.408	.142	1.975	2.784
IT	1659	.744	.351	.012	2.388
NRR	1659	1.494	1.526	-2.207	7.437
EG	1659	2.185	.267	-.396	2.454
URB	1659	4.126	.425	2.203	4.605
FDI	1659	1.013	1.352	-6.524	6.107
GFN	1659	2.373	.552	-.174	4.528

REU	1659	2.365	1.526	-4.665	4.514
FD	1659	4.014	.727	-1.681	5.542
LF	1659	15.856	1.586	11.941	20.5
GNS	1659	3.081	.461	-.42	4.203
INF	1659	4.148	1.059	.013	5.36
MT	1659	4.07	.541	2.753	5.839

3.9.2 Descriptive analysis of Model 2

Each observation's identification number or code is represented by the "ID" variable. There are 1659 observations in total, ranging from 1 to 79. This variable functions as a unique identifier for each data point. The "Years" variable represents the year of each observation. The data set spans the years 1999 to 2019, with 2009 as the median year. The standard deviation of 6.057 indicates that the years represented in the dataset are variable. The variable "EE" represents an environmental efficiency metric. The mean is 1.479, and the standard deviation is 0.413. Minimum value of 0.278 and maximum value of 3.339 represent the variation range for the environmental efficiency measure. The "IT" variable represents international commerce. The mean is 0.744, and the standard deviation is 0.351. The range of variation in international commerce is indicated by a minimum value of 0.012 and a maximum value of 2.388. The variable "NRR" represents the utilisation or rent of natural resources. It has an average value of 1.494 and a standard deviation that is relatively high at 1.526. The minimum value of -2.207 and the utmost value of 7.437 indicate substantial variation in the utilisation of natural resources. The variable "EG" represents environmental conservation initiatives or endeavours. The average value is 2.185, and the standard deviation is only 0.267. The range between the minimum value of -0.396 and the utmost value of 2.454 indicates the extent of environmental conservation efforts. The "URB" variable stands for urbanisation. The mean value is 4.126, and the standard deviation is 0.425%. The range of variation in urbanisation levels is denoted by the minimum value of 2.203 and the utmost value of 4.605. Foreign direct investment is what the variable "FDI" stands for. However, only 1648 observations are available for this variable. The mean value is 1.013, and the standard deviation is 1.352. The range of variation in foreign direct investment is indicated by the minimum value of -6.524 and maximum value of 6.107. "GFN" is a variable that represents green finance. The mean value is 2,373 and the standard deviation is 0.552. The range of variation in green finance is denoted by a minimum value of -0.174 and a maximum value of 4.528. The variable "REU" represents the use of renewable energy. It has an average value of 2.365 and a standard deviation that is relatively high at 1.526. The minimum value of -4,665 and the maximum value of 4,514 indicate the range of renewable energy consumption. The "FD" variable stands for financial development. The mean value is 4.014, and the standard deviation is 0.727. Minimum value of -1,681 and maximum value of 5,542 indicate the range of financial development variation. "LF" is a variable that represents labour force participation. Its mean value is 15.856 and its standard deviation is 1.586. Minimum value of 11.941 and maximum value of 20.5 indicate the range of labour force participation variation. The "GNS" variable represents a measure of gross national savings. The mean value is 3.081, and the standard deviation is 0.461. The range of variation in economic growth or gross national savings is denoted by the minimal value of -0.42 and the maximum value of 4.203. The "INF" variable represents infrastructure. The mean value is 4.148, and the standard deviation is 1.059. Minimum value of 0.013 and maximum value of 5.36 indicate the range of inflationary variation. The variable

"MT" represents as merchandise trade. The mean value is 4.07, and the standard deviation is 0.541. Minimum value of 2.753, maximum value of 5.839 indicate variation in economic development or modernization.

Table 3.3 Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
ID	1659	40	22.81	1	79
Years	1659	2009	6.057	1999	2019
EE	1659	1.479	.413	.278	3.339
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EG	1659	2.185	.267	-.396	2.454
URB	1659	4.126	.425	2.203	4.605
FDI	1659	1.013	1.352	-6.524	6.107
GFN	1659	2.373	.552	-.174	4.528
REU	1659	2.365	1.526	-4.665	4.514
FD	1659	4.014	.727	-1.681	5.542
LF	1659	15.856	1.586	11.941	20.5
GNS	1659	3.081	.461	-.42	4.203
INF	1659	4.148	1.059	.013	5.36
MT	1659	4.07	.541	2.753	5.839

3.10 Analysis Tools and Techniques

Panel data analysis requires a thorough examination of cross-sectional dependence (CD), which can be accomplished with the appropriate techniques and resources (Maddala and Wu 1999). No nation can function independently in this age of globalisation, and nations are dependent on one another on both an economic and financial level (De Hoyos and Sarafidis 2006). As a result, an economic shock in one country may have an impact on the economies of other nations, which could result in the cross-sectional dependence issue in panel data error terms (Pesaran 2004). Because the first-generation test cannot identify the cross-sectional reliance and can mistakenly reject the null hypothesis, the cross-sectional dependence test aids in determining whether to employ the first generation or second generation panel unit root test. Pesaran's CD test is therefore carried out in order to investigate cross-sectional dependence. Then, Researcher used Pesaran's (2007) cross-section augmented Dickey-Fuller (CADF) and cross-section Pesaran (CIPS) tests, which are second-generation unit root tests. Researcher used two co-integration tests, a la Westerlund (2007), to prevent the occurrence of spurious regression. Even in the presence of serial correlation, heteroskedasticity, cross-sectional dependence, and structural discontinuities, Westerlund (2007) achieves successful results. As a result, it is thought to be more effective than other comparisons.

The research contributes three significant benefits to previous work. First, the present research differs from others in that it investigates the relationship among carbon dioxide emissions as well as green finance, and not just the effect of green finance on environmental concerns but also on energy efficiency. Second, the fully modified ordinary least squares (FMOLS), dynamic ordinary least square (DOLS), as well as systematic generalized method of moment (GMM) models capture the multidirectional and asymmetric relationships between green finance and environmental pollution. This analysis method used by Wu, D., & Song, W. (2023) and Liu et al., (2023). This study concentrates on the 79 nations, that are users of green finance. Therefore, scientific evidence on the effect of green finance on carbon dioxide emissions can be used to compare the performance of various nations and economies.

3.10.1 Descriptive Statistic

A descriptive statistic is a concise descriptive coefficient that summarizes a given data set. This data set can depict the entire population or just a representative sample. Using descriptive statistics, Researcher can calculate the standard deviation and measure of central tendency. The deviation measures include the minimum value, the maximum value, the standard deviation, and other values. The measurements of central tendency consist of the mean value, the median value, and the mode value, correspondingly. Statistics that characterize and summarise the behavior of the study's variables are known as descriptive statistics.

3.10.2. Test For Multicollinearity

Multicollinearity is the phenomenon that occurs when two or more of the pertinent components in a model with multiple regression are highly correlated (Greene, 2003). This phenomenon is amenable to measurement. Multicollinearity is a problem that occurs when multiple variables have a nearly ideal linear relationship (Gujarati, 2022). Hamilton (2012) identifies a multicollinearity problem when the bivariate regression coefficients between combined indicator components exceed 0.80. This indicates that there is a strong correlation between the factors. In the event that contrasting explanatory factors correlate excessively, the evaluated parameter will become unreliable, and the indicators will lose significance (Field, 2009). The construction of a correlation matrix is one of the methods that can be used to identify multicollinearity. The matrix of variable correlations depicts the relationship between the variables used to explain the phenomenon. According to a rule of thumb established by Field (2009), a correlation score greater than 0.8 may raise red alarms. It provides both direction and vitality to a relationship simultaneously.

3.10.3. Test For Heteroscedasticity

According to research conducted by J. Hair (2009), homoscedasticity and heteroscedasticity refer, respectively, to the equality and inequality of the variability of the error term in regression equations. Randomly selected variables are presumed to have identical and independent distributions when performing regression. This indicates that these variables vary for each observation in a given data set. This pattern of conduct is known as homoscedasticity. When they are not, significant problems arise for the estimations, necessitating adjustments so that researchers can obtain reliable numbers. Heteroscedasticity can occur when the model's parameters are incorrect or when improper data transformation is performed. Because of this, there is a change in the variance of the dependent variable (J. Hair, 2009). In practise, heteroscedasticity may manifest itself if distinct observations have different error variances. The Breusch-Pagan or Cook-Weisberg test was applied to each regression model to determine whether or not the residual variance exhibited heteroscedastic behaviours. If the p-value is less than 0.05 percent, it indicates that the variance of the dependent variables exhibits heteroscedasticity. Consequently, the model should be regressed using the least-squares estimator in conjunction with robust standard regression.

3.10.4 Homogeneity Slope

In the context of panel regression models, it is typical to presume that the slope coefficients are constant throughout the entire cross-section. Nonetheless, it is crucial to recognize that this assumption may not always hold true in real-world situations, resulting in potential inconsistencies and misleading interpretations (Blomquist & Westerlund, 2016; Hsiao, 2022). Before proceeding with analysis, it is essential to examine the validity of the slope homogeneity assumption.

The test by Pesaran et al., (2008) and the Blomquist and Westerlund (Blomquist et al., 2013) Heteroskedasticity and Autocorrelation Consistent (HAC) robust test are utilized to determine the presence of slope heterogeneity in this study.

These experiments provide valuable insight into the potential variations in slope coefficients across our panel data cross-section.

3.10.5 Cross-Sectional Dependence

Panel data analysis requires a thorough examination of cross-sectional dependence (CD), which can be accomplished with the appropriate techniques and resources (Maddala and Wu 1999). The starting point for our inquiry is therefore CD. The results of the numerous CD tests put out by researchers like Balaguer and Ripollés (2016) and Cho et al. (2015).

3.10.6 Panel Unit Root Test

Second, 1st-generation unit root tests, such as the ADF-Fisher chi-square, were anticipated earlier (Saeed Meo and Karim 2022), but they might not perform as well as expected due to the presence of CD in the data set. Due to this, Researcher used the CIPS and CADF test of stationarity to identify and eliminate any potential cross-dependency in the panel data (Nabeeh et al., 2021). The first and second generation unit root tests for the CSD are performed on these data. The IPS can be explained (Purnamawati 2021)**.**

3.10.7 Panel Cointegration Test

The next step in this inquiry will involve the cointegration test. When the two series are integrated of equal order, the interest variables exhibit a long-term correlation. Long-term equilibrium processes can be located using cointegration. Cointegration analysis by Panel. To determine whether regression findings are spurious, it is necessary to investigate the outcomes from the panel cointegration tests. Given the outcomes, it is appropriate to examine the cointegration of the three variables. This article employs three types of Fisher panel cointegration tests, namely Pedroni's (2004), Kao's (1999), and Durbin Hausman men cointegration test was developed by Westerlund and Edgerton (Westerlund and Edgerton 2008). A panel cointegration framework for energy consumption is implemented as follows, allowing for considerable heterogeneity. Without requiring any prior knowledge of the integration sequence of variables, this test enables the calculation of the cross-sectional dependence ratio. As a result, it is relevant in circumstances like those in the following list.

3.10.8 FMOLS Estimation

The FMOLS (Fully Modified Ordinary Least Squares) estimation method is particularly advantageous when dealing with cointegrated panels because it addresses the two most important issues: endogeneity bias and serial correlation. FMOLS provides consistent and efficient estimators of the long-run relationship by considering these factors. In the presence of heterogeneous cointegrated panels in which the cointegration relationship may vary across individuals or cross-sections, FMOLS is considered the most appropriate method. It accounts for diverse cointegrating vectors in dynamic panels, which corresponds to the cross-sectional heterogeneity observed in recent research on panel unit roots and panel cointegration (Hamit-Naggar, 2012).

By comparing the asymptotic properties of various estimators based on aggregating along the 'within' and 'between' dimensions of the panel, FMOLS emerges as a reliable method for estimating cointegrating relationships in heterogeneous panel data. It overcomes endogeneity bias and serial correlation, allowing for consistent and efficient estimation of the long-run relationship between variables in the presence of cointegrated panels (Pedroni, 2001).

3.10.9 DOLS Estimation

The PDOLS (Panel Dynamic Ordinary Least Squares) estimator is an extension of the DOLS (Dynamic Ordinary Least Squares) technique for individual time series. DOLS is a straightforward and effective technique for estimating the cointegrating vector, which represents the long-term relationship between variables. The PDOLS estimator extends the use of DOLS to panel time-series data, whereas DOLS is typically applied to nonstationary data with a cointegrating relationship. This enables the analysis of data exhibiting cointegration and nonstationary across multiple cross-sectional units. Using the PDOLS method, researchers can estimate the cointegrating vector in panel time-series data while taking the dataset's dynamics and potential cross-sectional heterogeneity into account. The addition of DOLS to panel data permits the examination of long-run relationships across multiple entities or cross-sections, thereby disclosing the common factors that influence the variables of interest (Neal, 2014).

CHAPTER FOUR

BASIC DATA ANALYSIS

4.1 Basic Analysia Model 1

4.1.1 VIF And Correlation Matrix

Table 4.1 displays the estimated correlations between the variables. A correlation matrix between several variables is shown in the table. The correlation coefficient between the respective pair of variables is shown in each cell of the table. The degree and direction of the linear link between two variables are measured by the correlation coefficient. environmental pollution and GFN have a correlation value of -0.1007. This suggests that these variables have a shaky negative linear relationship. Although the association is not particularly strong, there is a minor trend for GFN to decline as environmental pollution levels rise. environmental pollution and FDI have a correlation value of -0.213. This suggests that environmental pollution and FDI have a slender negative linear connection. There is a minor tendency for FDI to decline as environmental pollution levels rise. The correlation, nevertheless, is not very strong. environmental pollution and EG have a correlation value of 0.0655. This suggests that environmental pollution and EG have a shaky positive linear connection. There is a modest trend for EG to rise when environmental pollution concentration rises. The link is insignificant, though. environmental pollution and URB have a correlation value of 0.0746. This shows that environmental pollution and URB have a shaky positive linear connection. There is a minor tendency for URB to grow when environmental pollution levels rise. The correlation, nevertheless, is not very strong. environmental pollution and IT have a correlation value of -0.1139. This suggests that environmental pollution and IT have a shaky negative linear relationship. There is a minor tendency for IT to decline as environmental pollution levels rise. The link is insignificant, though. environmental pollution and NRR have a correlation value of 0.1716. This shows that environmental pollution and NRR have a shaky positive linear connection. There is a minor tendency for NRR to rise when environmental pollution concentration rises. The correlation, nevertheless, is not very strong. environmental pollution and REU have a correlation value of -0.308. This suggests that environmental pollution and REU have a moderately negative linear relationship. The REU has a propensity to decline as environmental pollution concentration rises. Compared to other variables, the association is comparatively stronger. environmental pollution and FD have a correlation value of 0.1832. This shows that environmental pollution and FD have a shaky positive linear relationship. There is a very modest tendency for FD to rise when environmental pollution levels rise. The correlation, nevertheless, is not very strong.

In general, there is little to no link between environmental pollution and the other variables. The associations between these variables may be influenced by other factors, thus it's crucial to remember that correlation does not imply causality. To completely comprehend the correlations between the variables, more research and consideration of other aspects are required.

Table 4.1 VIF and Correlation Matrix

	VIF	**EVP**	**GFN**	**FDI**	**EG**	**URB**	**IT**	**NRR**	**REU**	**FD**
EVP		1								
GFN	1.14	-0.1007	1							
FDI	1.1	-0.213	-0.0282	1						
EG	1.47	0.0655	-0.0834	0.055	1					
URB	1.67	0.0746	-0.0312	0.1257	0.5009	1				
IT	1.11	-0.1139	-0.0912	0.2302	0.1607	0.2017	1			
NRR	1.28	0.1716	0.336	-0.0474	0.0001	0.1095	-0.0736	1		
REU	1.27	-0.308	0.0283	-0.1419	-0.2359	-0.4326	-0.1433	-0.1414	1	
FD	1.46	0.1832	-0.1357	0.1897	0.4263	0.3918	0.1173	-0.2409	-0.2083	1

The Variance Inflation Factor (VIF) gauges how much a regression model's variables are multicollinear. High multicollinearity is indicated by a high VIF, which suggests that the variable has a strong correlation with other variables in the model. On the other hand, a low VIF indicates less multicollinearity. The URB variable's VIF is 1.67, which denotes a moderate degree of multicollinearity. The VIF result of 0.597856 indicates that the model's other variables can account for about 59.79% of the variance in URB. The EG variable's VIF is 1.47, which likewise denotes a significant degree of multicollinearity. According to the VIF value of 0.678057, the other variables in the model may account for roughly 67.81% of the variance in EG. A moderate amount of multicollinearity is again shown by the VIF of 1.46 for the FD variable. According to the VIF value of 0.683064, the model's other variables may account for roughly 68.31% of the variance in FD. The NRR variable's VIF is 1.28, which shows that multicollinearity is not very prevalent. The VIF value of 0.781039 indicates that other model variables may account for about 78.10% of the variance in NRR. The REU variable's VIF is 1.27, which also denotes a minimal amount of multicollinearity. The VIF value of 0.786590 indicates that other model variables may account for about 78.66% of the variance in REU. The GFN variable's VIF is 1.14, which shows that multicollinearity is not a major issue. The VIF score of 0.874234 indicates that the other variables in the model can account for about 87.42% of the variance in GFN. A low amount of multicollinearity is also shown by the VIF of 1.11 for the IT variable. The VIF value of 0.898928 indicates that other model variables may account for about 89.89% of the variance in IT. The FDI variable's VIF is 1.10, which indicates very little multicollinearity. The VIF score of 0.908768 indicates that the other variables in the model can account for about 90.88% of the variance in FDI.

The average VIF score across all variables is 1.31, which shows that multicollinearity is generally not a problem in the overall model. This implies that the model's variables have low correlations with one another, which is often preferred in regression analysis.

4.1.2 Cross Sectional Dependency Test

The CD-test statistic assesses how much the variables depend on one another cross-sectionally. A stronger reliance is indicated by higher CD-test results. The cross-sectional dependency's statistical significance is indicated by the p-value attached to each CD-test. All variables in this situation have p-values of 0, which shows a strong cross-sectional dependency. The number of joint significant variables across all cross-sectional regressions is represented by the average joint value. The result of 21 in this instance indicates a considerable presence of joint significant factors. The cross-sectional dependency's strength is gauged using the T statistic. Stronger dependencies are indicated by higher T statistic values. The average pairwise correlation between the variables is represented by the mean. Higher values denote a higher average correlation; the range is 0 to 1. The cross-sectional dependence test findings for various variables are shown in the table.

With a p-value of 0.000 and a CIPS statistic of 25.345 for environmental pollution, there is substantial evidence of cross-sectional dependency. The average combined significance level is 21.00, indicating that the variables are significantly correlated. The median cross-sectional reliance, or rho, is 0.10, which denotes a moderate amount of dependence. With a p-value of 0.000 and a CIPS statistic of 50.887 for the GFN varaiable, there is substantial evidence of cross-sectional dependency. The average combined significance level is 21.00, indicating that the variables are significantly correlated. The median cross-sectional dependence is 0.20, which is a moderate value. With a p-value of 0.000 and a CIPS statistic of 28.758, the FDI statistic clearly shows cross-sectional dependency. The average combined significance level is 21.00, indicating that the variables are significantly correlated. The median cross-sectional dependence is 0.11, which is considered to be moderate. With a p-value of 0.000 and a CIPS statistic of 173.579, EG clearly shows cross-sectional dependency. The average combined significance level is 21.00, indicating that the variables are significantly correlated. With a mean of 0.68, there is a significant amount of cross-sectional dependence. With a p-value of 0.000 and a CIPS of URB statistic of 136.636, there is significant evidence of cross-sectional dependency. The average combined significance level is 21.00, indicating that the variables are significantly correlated. The mean cross-sectional dependence is moderate, as indicated by the mean of 0.54. With a p-value of 0.000 and a CIPS statistic of 6.126 for IT, there is substantial evidence of cross-sectional dependency. The average combined significance level is 21.00, indicating that the variables are significantly correlated. The median value, 0.02, suggests a negligible degree of cross-sectional dependence. With a p-value of 0.000 and a CIPS statistic of 81.602 for NRR, there is substantial evidence of cross-sectional dependency. The average combined significance level is 21.00, indicating that the variables are significantly correlated. The median cross-sectional dependence is 0.32, which is considered to be moderate. With a p-value of 0.000 and a CIPS statistic of 18.898, the REU statistic clearly shows cross-sectional dependence. The average combined significance level is 21.00, indicating that the variables are significantly correlated. With a mean of 0.07, there is little cross-sectional dependence. Strong evidence of cross-sectional dependency may be seen in the CIPS statistic of FD, which is 32.542 with a p-value of 0.000. The average combined significance level is 21.00, indicating that the variables are significantly correlated. With a mean of 0.13, there is little cross-sectional dependence.

The findings show that the variables have a high cross-sectional dependency, indicating that they are connected. Across variables, the degree of cross-sectional reliance varies, with some variables exhibiting higher levels of dependence than others.

Table 4.2 Cross Sectional Dependency Test

Variables	CD-test	p value	average joint T	mean ρ	means abs(ρ)
EVP	25.345	0	21	0.1	0.61
GFN	50.887	0	21	0.2	0.3
FDI	28.758	0	21	0.11	0.25
EG	173.579	0	21	0.68	0.76
URB	136.636	0	21	0.54	0.82
IT	6.126	0	21	0.02	0.46
NRR	81.602	0	21	0.32	0.41
REU	18.898	0	21	0.07	0.6
FD	32.542	0	21	0.13	0.39

4.1.3 Heteroskedasticity Test

Table 4.3 Heteroskedasticity Test

H0: Constant variance	
chi2(1)	9.62
Prob > chi2	0.0019

In the analysis presented, the H0: Constant variance hypothesis is being tested. This hypothesis's test statistic is chi2(1) with an average of 9.62. The p-value associated with the above test is 0.0019.

Researcher may deny the null hypothesis of a constant variance based on these results. The obtained p-value of 0.0019 is less than the standard significance level of 0.05, indicating that there is significant proof against the assumption of a constant variance. The significance of this finding for our thesis is that it indicates that the variation of the variables within the study is not constant. Instead, it is probable that the variance varies across the observed data, indicating the possibility of heteroscedasticity.

4.1.4 Slope of Homogeneity

The slope of homogeneity, together with the accompanying delta values and p-values, are shown in the table. A statistical test to determine if the slopes of various regression lines are identical is the slope of homogeneity. The estimated slopes of the regression lines are contrasted by the delta values. The Delta number, which stands for considerable deviation from zero, is 18.893. This shows that the slopes of the variables are heterogeneous. Less than the standard significance level of 0.05, the p-value is 0.000. This results in the rejection of the null hypothesis of homogeneity and adds to the body of evidence supporting the existence of slope heterogeneity.

Table 4.4 Testing for Slope of Homogeneity

H0: slope coefficients are homogenous

	Delta	**p-value**
	18.893	0
adj.	26.104	0

The results show that the slopes of homogeneity, both unadjusted and corrected, are substantially distinct from zero (p 0.05). This implies that the slopes of the regression lines show signs of heterogeneity, showing that the link between the variables varies across different groups or conditions. To comprehend the consequences of these slope differences more fully, it is critical to conduct additional analysis and interpretation of the particular variables and regression models. The overall findings point to a large amount of variation in the slopes of the variables, which suggests that the correlations between the variables may vary and are not always constant.

4.1.5 Second Generation Unit Root Test

The CIPS and CADF tests' findings for each variable's level and first difference are shown in the table. CIPS is for Cross-Sectionally Augmented IPS, and CADF stands for Cross-Sectionally Augmented Dickey-Fuller. The presence of a unit root, which determines whether the series is stationary or not, is measured using the CIPS test statistic for the level of each variable. CIPS statistics that are both negative and significant imply that the series is stationary at the level. The stationarity of the differenced series is determined by the CIPS test statistic for the first difference of each variable. The differenced series is likely stationary, according to a weak and substantial CIPS statistic.

The stationarity of the differenced series is assessed using the CADF test statistic for each variable's initial difference. Stationarity is indicated by a negative and substantial CADF value. The negative and large CIPS and CADF statistics demonstrate that the series for environmental pollution is stationary both at the level and following the initial difference. The negative and substantial CIPS statistic for the first difference demonstrates that the NRR series is not stationary at the level but that it does become stationary after differencing. The stationarity is confirmed by the fact that the CADF statistic for the first difference is also unfavorable and substantial. The CIPS and CADF statistics are negative and significant, indicating that the series for IT is stagnant both at the level and after differencing. The CIPS statistic for the first difference is negative and significant, indicating that the series for EG is not stationary at the level but does become stationary after differencing. The stationarity is confirmed by the fact that the CADF statistic for the first difference is also unfavorable and substantial.

Table 4.5 Second Generation Unit Root Test

Series	CIPS		CADF	
	Level	First difference	Level	First difference
EVP	-2.179***		-2.179***	
NRR	-1.853	-3.929***	-1.930**	
IT	-2.398***		-2.630***	
EG	-1.978	-3.126***	-1.917**	
URB	-1.225	-2.157**	-1.315	-2.092***
FDI	-3.229***		-2.469***	-4.414***
GFN	-3.628***		-2.965***	
FD	-1.597	-3.606***	-2.071***	
REU	-1.549	-4.251***	-1.549	-4.251***

The non-significant CIPS and CADF statistics show that the URB series is not stationary at the level. The first difference's negative and substantial CIPS and CADF statistics, however, demonstrate that the series becomes significantly stationary after differencing at 5%. The negative and substantial CIPS and CADF statistics for the first difference show that the series for FDI is not stationary at the level but becomes stationary after differencing.

The series is not stationary at the level, but differencing causes it to become stationary, as evidenced by the first difference's negative and substantial CIPS and CADF statistics. The negative and substantial CIPS and CADF statistics for the first difference show that the series is not stationary at the level but that it becomes stationary after differencing. The series is not stationary at the level, but differencing causes it to become stationary, as evidenced by the first difference's negative and substantial CIPS and CADF statistics.

Overall, the results of the CIPS and CADF tests show that the variables are stationary. For time series analysis, stationarity is crucial since it provides accurate model estimation and forecasting. The findings imply that while certain variables require differencing to attain stationarity, others are stationary at the level.

4.1.6 Cointegration Test

- *Kao Cointegration Test*

The Kao cointegration examination was administered to determine whether the variables that are important cointegrated. The results of all the unit root tests, which include the , augmented D-F t, and Modified Dickey-Fuller, all indicate statistically important t-statistics and p-values of 0 or very close to 0.

Table 4.6 Kao cointegration test

Kao cointegration test	**t Statistic**	**p-value**
Modified Dickey–Fuller	5.0199	0
Dickey–Fuller	5.7757	0
Augmented Dickey–Fuller t	6.1949	0
Unadjusted modified Dickey–Fuller	3.2743	0.0005
Unadjusted Dickey–Fuller t	3.5868	0.0002

These findings suggest that the variables in question exhibit cointegration, indicating an ongoing connection between them. Cointegration indicates that the variables advance together in over time and are not driven by random fluctuations alone. The statistically significant t-statistics along with small p-values from the unit root tests offer evidence against the null assumption of non-stationarity, suggesting that the variables are constant and have a stable long-term relationship.

- *Pedroni Cointegration Test*

Table 4.7 Pedroni Cointegration Test

	Statistic	p-value
Modified Phillips–Perron t	9.0559	0
Phillips–Perron t	-4.1336	0
Augmented Dickey–Fuller t	-3.2006	0.0007

The Pedroni's cointegration test was administered to determine whether the variables of interest cointegrated. The test results, which include the Modified Phillips-Perron t, Phillips-Perron t, and the augmented Dickey-Fuller t statistics, indicate statistical significance and p-values of 0 or close to 0. The statistically significant test statistics and low p-values from the Pedroni cointegration test indicate the existence of cointegration between the variables. This suggests a long-term relationship between the variables and indicates that they move together over time, as opposed to being driven solely by random fluctuations.

The results of the Pedroni cointegration test are essential to the thesis because they corroborate the existence of a stable and significant relationship between the investigated variables. These findings provide a firm basis for further analysis and interpretation of the interrelationships and dynamics between variables. In addition, the statistically significant test statistics and low p-values generated by the Modified Phillips-Perron t, Phillips-Perron t, as well as Augmented Dickey-Fuller t tests suggest the variables are stationary and possess a stable long-run relationship. Overall, the results of the Pedroni cointegration test support the research objectives and contribute to a solid analysis of the relationships between the variables. They strengthen the credibility and validity of the thesis's findings and offer valuable insights into the long-term trends of the variables.

- *Westerlund Cointegration Test*

Table 4.8 Westerlund Cointegration Test

Westerlund cointegration test	Statistic	p-value
Variance	-5.2292	0

The Westerlund cointegration test determines whether or not variables are cointegrated. Cointegration suggests that the variables have a long-term relationship or equilibrium. The Westerlund test statistic in this instance is -5.2292, and the corresponding p-value is 0.

Researcher can conclude based on the test results that there is evidence of cointegration between the variables. The negative test statistic suggests that the variables have a long-term inverse relationship. The p-value of 0 indicates that the test results are statistically significant, providing additional support for cointegration. This implies that changes in one variable will have an enduring effect on the other variables, enabling the analysis of long-term dynamics and relationships. Overall, the Westerlund cointegration test results provide empirical support for the presence of cointegration among the variables and validate the use of additional analyses and modeling techniques to investigate the long-term relationships in our thesis research.

4.2 Basic Analysis Model 2

4.2.1 VIF and Correlation matrix

Since they represent the correlation of a variable with itself, the diagonal entries of the correlation matrix are always 1. The entries that are off the diagonal show the correlation indices between two pairs of variables. For instance, "environmental pollution" and "GFN" have a correlation coefficient of -0.1007, which shows a sluggishly negative connection between these two variables. According to this, there may be a modest relationship between increased green funding and lower environmental pollution. Foreign Direct Investment: The correlation between environmental pollution and FDI is negative (-0.213), showing that higher levels of FDI are linked to somewhat lower environmental pollution. Economic growth (EG) and environmental pollution have a sluggishly positive association (0.0655), which suggests that higher economic growth is correlated with marginally higher environmental pollution. Urban population, or URB: According to a weakly positive association between environmental pollution and URB (0.0746), a greater urban population is linked to marginally higher environmental pollution. IT (Information Technology): The weak negative correlation between environmental pollution and IT (-0.1139) indicates that the use of information technology is inversely related to environmental pollution. NRR (Natural Resource Rents): The correlation between environmental pollution and NRR is weakly positive (0.1716), suggesting that greater natural resource rents are linked to marginally higher environmental pollution. REU (Renewable Energy usage): The correlation between environmental pollution and REU is negative (-0.308), suggesting that greater usage of renewable energy is linked to marginally reduced environmental pollution. A small positive correlation (0.1832) between environmental pollution and FD (financial development) suggests that higher levels of FD are correlated with marginally higher environmental pollution.

Table 4.9 VIF and Correlation Matrix

	VIF	EE	GFN	FDI	EG	URB	IT	NRR	REU	FD
EE		1								
GFN	1.14	0.1176	1							
FDI	1.1	-0.0046	-0.0282	1						
EG	1.47	0.0972	-0.0834	0.055	1					
URB	1.67	0.0778	-0.0312	0.1257	0.5009	1				
IT	1.11	0.0682	-0.0912	0.2302	0.1607	0.2017	1			
NRR	1.28	-0.0367	0.336	-0.0474	0.0001	0.1095	-0.0736	1		
REU	1.27	0.0299	0.0283	-0.1419	-0.2359	-0.4326	-0.1433	-0.1414	1	
FD	1.46	0.086	-0.1357	0.1897	0.4263	0.3918	0.1173	-0.2409	-0.2083	1

4.2.2 Cross-Sectional Dependency Test

Table 4.10 Cross-Sectional Dependency Test

Variable	CD-test	p-value	average joint T	mean ρ	mean abs(ρ)
EE	254.364	0	21	1	1
NRR	81.602	0	21	0.32	0.41
IT	6.126	0	21	0.02	0.46
EG	173.579	0	21	0.68	0.76
URB	136.636	0	21	0.54	0.82
FDI	28.758	0	21	0.11	0.25
GFN	50.887	0	21	0.2	0.3
REU	18.898	0	21	0.07	0.6
FD	32.542	0	21	0.13	0.39
LF	115.1	0	21	0.45	0.78
GNS	14.467	0	21	0.06	0.35
INF	222.697	0	21	0.88	0.88
MT	39.975	0	21	0.16	0.43

In panel data models, the CD-test quantifies cross-sectional dependence. It evaluates whether the variables' considerable cross-sectional dependence. The CD-test's related p-value. Strong evidence is presented against the null hypothesis that there is no cross-sectional dependence when the p-value is zero. For the CD-test, all the variables in the analysis had p-values of 0, which is strong evidence of the variables' cross-sectional dependence. All variables' "Average Joint T" values are 21, indicating a consistent test statistic across all observations. Values for "Mean" range from 0.02 to 0.88. The average correlation coefficients between the relevant variable and the other variables are represented by these values. Stronger average correlations are shown by higher values. The value of mean abs(ρ) range from 0.25 to 0.88. The correlation coefficients between the relevant variable and the other variables are represented by these numbers as their average absolute values. Stronger average absolute correlations are indicated by higher values. Overall, the findings point to cross-sectional dependence between the variables, which is supported by the CD-test findings.

4.2.3 Heteroskedasticity Test

To determine whether there is evidence of unequal variances (heteroskedasticity) in the residuals of a regression model, researchers employ the Breusch-Pagan/Cook-Weisberg test. The constant variance, or null hypothesis (Ho), that there is equal variation in the residuals at all levels of the independent variables, is what is being tested.

Table 4.11 Heteroskedasticity Test

Ho: Constant variance
Variables: fitted values of EE

chi2(1)	2.27
Prob > chi2	0.1321

The chi-square statistic produced for the test, with 1 degree of freedom, is denoted as "chi2(1)". The chi-square statistic calculates the discrepancy between the test's observed and predicted values. The chi-square statistic has a value of 2.27. The chi-square statistic's p-value is denoted by "Prob > chi2". If the null hypothesis is true, it represents the likelihood of observing a chi-square value as extreme as the calculated statistic. Researcher lack sufficient data to reject the null hypothesis because the p-value (0.1321) exceeds the standard significance level of 0.05. This implies that the regression model's residuals do not contain any discernible heteroskedasticity. To put it another way, the test does not offer compelling evidence that the variances of the residuals fluctuate considerably across levels of the independent variable (fitted values of EE).

4.2.4 Slope of Homogeneity

Table 4.12 Slope of Homogeneity

H0: slope coefficients are homogenous

	Delta	**p-value**
	23.606	0
adj.	32.616	0

The table shows the outcomes of the Pesaran and Yamagata (2008) method's test for slope heterogeneity. The slope coefficients are homogenous, which means they are the same for all groups or observations, is the null hypothesis (H0) being tested. The table's "Delta" column lists the test statistic or heterogeneity measure. Here, the first row displays a Delta value of 23.606 whereas the "adj." second row displays an altered or alternate result with a Delta value of 32.616.

The associated p-values for the test are displayed in the "p-value" column. The strength of the evidence opposing the null hypothesis is gauged by the p-value. The p-values are presented as 0 in both situations. Strong evidence is presented against the null hypothesis of slope coefficient homogeneity when the p-value is zero. According to this, it is extremely unlikely that the observed variability in the slope coefficients would exist under the homogeneity assumption. As a result, you would likely find slope heterogeneity among the coefficients and reject the null hypothesis.

4.2.5 Second Generation Unit Root Test

The following interpretation is based on the findings of the panel unit root test utilizing the CIPS (Cross-sectionally Augmented IPS) and CADF (Cross-sectional Dependence Augmented Dickey-Fuller) tests: The EE series is stationary in the level form (significant at the 1% level), but it is not stationary in the first difference form. The series of NRR is not stationary in the level form, but it is (significant at the 1% level) stationary in the first difference form. The IT series is not stationary in the level form (significant at the 1% level), nor is it stationary in the first difference form (significant at the 1% level). The EG series is not stationary in the level form, but it is stationary in the first difference form (significant at the 1% level). The URB series is notably stationary on the first difference (significant at the 5%) but not stationary at the level. The series of FDI is not stationary in either the level form or the first difference form (significant at the 1% level), and both forms are non-stationary. The GFN series is not stationary in the level form (significant at the 1% level), nor is it stationary in the first difference form (significant at the 1% level). The series of FD is not stationary in the level form, but it is stationary in the first difference form (significant at the 1% level). The REU series is notably stationary on the first difference but not stationary at the level.

Table 4.13 Second Generation Unit Root Test

Series	CIPS		CADF	
	Level	**First difference**	**Level**	**First difference**
EE	-2.610***			-6.190***
NRR		-3.929***	-1.930**	
IT	-2.398***		-2.630***	
EG		-3.126***	-1.917**	
URB		-2.157**		-2.092***
FDI	-3.229***		-2.469***	-4.414***
GFN	-3.628***		-2.965***	
FD		-3.606***	-2.071***	
REU		-4.251***		-4.251***

The CADF test series of EE is stationary in the level form (significant at the 1% level), but it is not stationary in the first difference form (significant at the 1% level). The series of NRR is not stationary in the level form, but it is (significant at the 5% level) stationary in the first difference form. The IT series is not stationary in either the level form (significant at the 5% level) or the first difference form (significant at the 1% level). The EG series is not stationary in the level form, however it is stationary in the first difference form (significant at at the 5% level). In both the level form and the first difference form, the series is not stationary (significant at the 1% level), which is a problem. Both the level form and the first difference form of the GFN series exhibit non-stationarity (significant at the 1% level), respectively. The series of FD is not stationary in the level form, but it is (significant at the 1% level) stationary in the first difference form. The REU series is notably stationary on the first difference but not stationary at the level.

4.2.6 Cointegration Test

- *Kao Cointegration Test*

The table displays the outcomes of the Kao cointegration test, which is intended to detect if variables in a panel data setting have a long-term relationship (cointegration). The test uses several iterations of the Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) tests to look at the stationarity of the variables. the statistician's assessment of each test's results. These numbers are used to evaluate the variables' stationarity and find out whether cointegration is present. the p-value for every test statistic. The p-value, under the null hypothesis of non-stationarity, represents the likelihood of witnessing a test statistic that is as extreme as the computed value. All of the test statistics in your situation have p-values of 0, which is strong evidence against the non-stationarity null hypothesis. The Modified Dickey-Fuller t statistic is 6.5912 based on the findings. 8.2297 is the Dickey-Fuller t value. 7.9811 is the Augmented Dickey-Fuller t value. The t statistic for the Unadjusted Modified Dickey-Fuller test is 5.0819. Dickey-Fuller's unadjusted t value is 5.7121.

Table 4.14 Kao Cointegration Test

	Statistic	**p-value**
Modified Dickey–Fuller t	6.5912	0
Dickey–Fuller t	8.2297	0
Augmented Dickey–Fuller t	7.9811	0
Unadjusted modified Dickey–Fuller t	5.0819	0
Unadjusted Dickey–Fuller t	5.7121	0

Researcher can rule out non-stationarity as the null hypothesis for all test statistics because all the p-values are zero. This may indicate that there is proof of cointegration between the variables being examined. Cointegration means that the variables have a long-term link and move together over time.

- *Pedroni Cointegration Test*

Table 4.15 Pedroni Cointegration Test

	Statistic	p-value
Modified Phillips–Perron t	10.3397	0.000
Phillips–Perron t	-24.859	0.000
Augmented Dickey–Fuller t	-2.7423	0.003

The Pedroni's cointegration test is used to determine whether or not variables in a dataset are cointegrated. Cointegration implies that the variables are in long-term equilibrium. The test results and the p-value for the Modified Phillips-Perron (MPP), Phillips-Perron (PP), and Augmented Dickey-Fuller (ADF) tests are provided in this analysis.

The statistic for the MPP test is 10.3397, and the related p-value is 0. This indicates that the variables are strongly cointegrated. Likewise, the PP test statistic is -24.859 with a significance level of 0, providing additional evidence for cointegration. The test statistic for the ADF is -2.7423, and its corresponding p-value is 0.0031. This indicates that significant cointegration exists between the variables. This suggests that the variables move together over time, and that changes in one variable are likely to have enduring effects on the others. The findings of the Pedroni's cointegration test indicate that the variables used in our analysis are not erroneous and can be utilized to investigate long-term relationships further. This provides a solid basis for conducting the following analyses and methods of modeling in our thesis, allowing for a deeper comprehension of the interdependencies between the variables.

- *Westerlund Cointegration Test*

The Westerlund test for cointegration is used to investigate the presence of cointegration among a dataset's variables. Cointegration suggests that the variables have a long-term relationship. The test result and p-value associated with the Variance test are given in this analysis.

Table 4.16 Westerlund Cointegration Test

	Statistic	**p-value**
Variance	-6.2679	0

The test statistic for Variance is -6.2679, and the corresponding p-value is 0. This provides solid evidence of cointegration between the variables. The substantially low p-value suggests that the cointegration results can be relied upon with great assurance. The results indicate that the variables will not deviate significantly from the equilibrium relationship over the long term. The Westerlund cointegration test results provide a firm foundation for further analysis in our thesis, allowing us to investigate the long-term dynamics as well as connections between the variables. It indicates that modifications in one variable will likely have an enduring effect on the other variables.

CHAPTER FIVE

SPECIFICATION ANALYSIS

5.1 Regression Analysis Model 1

5.1.1 Linear Regression

Table 5.1 Linear Regression

CO_2	Coef.	St. Err.	t-value	p-value	[95%] Conf	Interval	Sig
GFN	-.006	.003	-2.36	.018	-.011	-.001	**
EG	.038	.006	6.80	0	.027	.049	***
FDI	-.006	.001	-6.43	0	-.008	-.004	***
URB	.052	.004	13.05	0	.044	.059	***
IT	-.033	.004	-8.14	0	-.041	-.025	***
NRR	0	0	1.81	.07	0	.001	*
FD	0	0	7.22	0	0	0	***
REU	-.023	.001	-30.17	0	-.025	-.022	***
LF	.08	.001	68.82	0	.078	.083	***
MT	.012	.003	3.53	0	.005	.019	***
INF	0	0	5.92	0	0	0	***
GNS	.002	.002	1.11	.266	-.002	.006	
Constant	.89	.039	22.97	0	.814	.966	***
Mean dependent var			2.409		**SD dependent var**	0.143	
R-squared			0.860		**Number of obs**	1659	
F-test			829.277		**Prob > F**	0.000	
Akaike crit. (AIC)			-4925.288		**Bayesian crit. (BIC)**	-4855.064	
*** *p<.01*, ** *p<.05*, * *p<.1*							

The coefficients (Coef.) show how each independent variable is thought to affect the dependent variable. For instance, a one-unit rise in "EVP" corresponds to a 0.006-unit drop in the dependent variable. The standard errors give a measurement of the degree of uncertainty in the calculated coefficients. More accurate estimations are shown by smaller standard errors. The t-values show how the estimated coefficient and its standard error are related. Greater absolute t-values denote relationships between the independent and dependent variables that are statistically more significant. The p-values evaluate each independent variable's statistical significance.

They provide the likelihood that the estimated association was discovered by pure coincidence. P-values that are lower (below the significance level) indicate more compelling evidence that there isn't a relationship. The confidence intervals show the range of possibilities for the genuine population coefficients. You may get an idea of how accurate the calculated coefficients are by looking at the 95% confidence interval. The percentage of variation in the dependent variable that can be explained by the independent variables is shown by the R-squared value (0.860). Higher numbers denote a better match, and it measures the regression model's goodness of fit. The F-test evaluates the regression model's overall significance.

The model appears to be statistically significant overall based on the provided F-test result (829.277) and its corresponding p-value (0.000). According to the regression results, the majority of the independent variables (apart from "GNS") appear to have statistically significant correlations with the dependent variable. A strong fit of the model is indicated by the R-squared value of 0.860. A one-unit increase in EVP is predicted to result in a 0.006-unit decrease in the dependent variable. one-unit increase in GFN is predicted to result in a 0.006-unit decrease in the dependent variable. The dependent variable is anticipated to increase by 0.038 units for every one-unit increase in EG. one-unit increase in FDI is predicted to result in a 0.006-unit decrease in the dependent variable. The dependent variable is predicted to increase by 0.052 units for every one-unit increase in URB. The dependent variable is anticipated to decrease by 0.033 units for every one-unit increase in IT. NRR has a coefficient of zero, indicating it has no effect on the dependent variable. FD has a coefficient of zero, indicating it has no effect on the dependent variable. The dependent variable is anticipated to decrease by 0.023 units for each unit increase in REU. A one-unit increase in LF is anticipated to result in a 0.08-unit increase in the dependent variable. The dependent variable is predicted to increase by 0.012 units for every one-unit increase in MT. INF has a zero coefficient, indicating that it has no effect on the dependent variable. The GNS coefficient is not statistically significant (p-value = 0.266), indicating that it has no significant effect on the dependent variable. The constant term represents the expected value of the dependent variable when all of the independent variables are set to zero. In this instance, 0.89 is the expected value.

5.1.2 Fully Modified Least Squares (FMOLS)

The dependent variable is environmental pollution, which most likely represents emissions of carbon dioxide. Panel fully modified least squares (FMOLS) is utilized, which is an estimation technique for panel data that addresses endogeneity and dynamic effects. In the panel dataset, the analysis contains 20 years and 75 cross-sections countries. There are a total of 1659 observations in the asymmetrical panel dataset. This analysis employs pooled estimation, which considers the panel dataset as a single large cross-section and disregards any individual-specific effects. The coefficient covariance is calculated using the method of choice.

Approximately 0.040300 is the coefficient for the FDI variable. It has an approximate standard error of 0.007659. The t-statistic is 5.262006, and the associated probability is 0.0000 (or 100 percent). The coefficient is positive, indicating a positive relationship with the dependent variable (environmental pollution), and it is statistically significant (p 0.01) with a high degree of confidence. Approximately -0.029437 is the coefficient for the variable GFN. It has an approximate standard error of 0.013148. The t-statistic is -2,238,943, and the associated probability is 0.0253 (or 2.5%). The coefficient is negative, indicating a negative relationship with the dependent variable (environmental pollution), and it is statistically significant at the standard level of significance (p 0.05).

Table 5.2 Panel Fully Modified Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GFN	-0.029437	0.013148	-2.238943	0.0253
EG	0.332028	0.038792	8.559159	0.0000
NRR	0.006006	0.002544	2.360676	0.0184
FDI	0.040300	0.007659	5.262006	0.0000
URB	0.160073	0.046383	3.451114	0.0006
IT	-0.131257	0.029206	-4.494264	0.0000

R-squared	0.946890	**Mean dependent var**	4.113189
Adjusted R-squared	0.943654	**S.D. dependent var**	2.107504
S.E. of regression	0.500264	**Sum squared resid**	349.1177
Long-run variance	0.618195		

Approximately -0.131257 is the coefficient for the variable IT. It has an approximate standard error of 0.029206. The t-statistic is -4,494,266 and the associated probability is 0.0000 (or 0%). The coefficient is negative, indicating a negative relationship with the dependent variable (environmental pollution), and it is statistically significant (p 0.01) with a high degree of confidence. NRR variable has a coefficient of approximately 0.006006. It has an approximate standard error of 0.002544. The t-statistic is 2.360676, and the associated probability is 0.0184 (1.84 percent). The coefficient is positive, indicating a positive relationship with the dependent variable (environmental pollution), and it is statistically significant at the standard level of significance (p 0.05). Approximately 0.160073 is the coefficient for the variable URB. It has an approximate standard error of 0.046383. The t-statistic is 3,451114, and the probability is 0.0006 (or 0.06%). The coefficient is positive, indicating a positive relationship with the dependent variable (environmental pollution), and it is statistically significant (p 0.01) with a high degree of confidence. Approximately 0.3320228 is the coefficient for the variable EG. It has an approximate standard error of 0.038792. The t-statistic is 8.559159, and the probability corresponds to 0.0000 (or 0%). The coefficient is positive, indicating a positive relationship with the dependent variable (environmental pollution), and it is statistically significant (p 0.01) with a high degree of confidence. Approximately 0.699134 is the coefficient for the variable LF. It has an approximate standard error of 0.062363. The t-statistic is 11.21070 and the probability is 0.0000 (or 0%). The coefficient is positive, indicating a positive relationship with the dependent variable (environmental pollution), and it is statistically significant (p 0.01) with a high degree of confidence. Approximately -0.100911 is the coefficient for the variable MT. It has an approximate standard error of 0.041476. The t-statistic is -2,433013, and the associated probability is 0.0151 (1.5%). The coefficient is negative, indicating a negative relationship with the dependent variable (environmental pollution), and it is statistically significant at the standard level of significance (p 0.05). The adjusted R-squared value is 0.946890, taking into account the number of model variables and observations. Mean dependent variable: The mean dependent variable (environmental pollution) value is approximately 4.113189. Standard deviation dependent variable: The standard deviation of the dependent variable (environmental pollution) is about 2.107504. The regression's standard error is approximately 0.500264. Approximately 349.1177 is the sum of squared residuals. The estimated long-term variance is approximately 0.618195.

5.1.3 Model 1 Mediation Effect of REU (FMOLS)

Table 5.3 MEDIATION EFFECT OF REU (FMOLS)

Variables	DEPENDENT EVP		DEPENDENT REU		DEPENDENT EVP	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
REU					-0.026296	0
GFN	-0.029437	0.0253	0.13261	0.003	0.017757	0.0903
EG	0.332028	0	0.277312	0.0401	0.325183	0
NRR	0.006006	0.0184	0.020114	0.0122	0.005304	0.0094
FDI	0.0403	0	-0.093098	0.0003	0.024162	0.0001
URB	0.160073	0.0006	-1.317429	0.0246	0.016688	0
IT	-0.131257	0	0.717265	0	0.051783	0.0235

R-squared	0.946890	**Mean dependent var**	4.113189
Adjusted R-squared	0.943654	**S.D. dependent var**	2.107504
S.E. of regression	0.500264	**Sum squared resid**	349.1177
Long-run variance	0.618195		

The mediation analysis conducted using the panel fully modified least squares (FMOLS) method reveals the effect of the mediator variable REU on the relationship between the independent variables (GFN, EG, NRR, FDI, URB, and IT) and the dependent variable environmental pollution. It is estimated that the coefficient for GFN is -0.029437 with a probability of 0.0253 (or 2.53%). This indicates a direct and negative relationship between GFN and environmental pollution. Nevertheless, the coefficient is statistically significant at the standard significance level ($p > 0.05$). The estimated coefficient for EG is 0.332028 with a probability of 0 (or 0%). This demonstrates a direct and positive relationship between EG and EVP. The coefficient is statistically significant (p 0.01) with a high degree of confidence. The estimated coefficient for NRR is 0.006006 with a probability of 0.0184 (1.84%). It indicates a direct and positive relationship between NRR and environmental pollution. At the conventional level of statistical significance (p 0.05), the coefficient is statistically significant. The estimated coefficient for FDI is 0.0403 with a probability of 0 (or 0%). It demonstrates a direct and positive relationship between FDI and environmental pollution. The coefficient is statistically significant (p 0.01) with a high degree of confidence. It is estimated that the coefficient for URB is 0.160073, with a probability of 0.0006 (or 0.06%). It indicates a direct and positive relationship between URB and environmental pollution. The coefficient is statistically significant (p 0.01) with a high degree of confidence. The estimated coefficient for IT is -0.131257 with a probability of 0 (or 0%). It indicates a direct negative correlation between IT and environmental pollution. The coefficient is statistically significant (p 0.01) with a high degree of confidence.

In a mediation analysis, the researcher undertaking the analysis can interpret the relationship between the independent variables and the mediator variable REU. In the context of the mediation analysis, the independent variables with the mediator REU can be interpreted as follows: With a probability of 0.0000 (or 0%), the coefficient for the mediator variable REU is estimated to be approximately -0.026296. This demonstrates that REU and environmental pollution have a significant direct relationship. GFN has a direct effect on REU, as indicated by its coefficient. A negative coefficient indicates that GFN is associated with a decrease in the mediator variable REU, whereas a positive coefficient indicates an increase in REU. This relationship is statistically significant if the coefficient's significance (probability value) is significant. The coefficient for EG represents the effect of EG directly on the mediator variable REU. A positive coefficient indicates that EG is associated with an increase in REU, while a negative coefficient indicates a decrease. The probability value indicates this relationship's statistical significance. The coefficient for NRR represents NRR's direct effect on the mediator variable REU. A positive coefficient indicates that NRR is associated with an increase in REU, whereas a negative coefficient indicates a decrease. The significance level (probability) assists with determining the statistical significance of this relationship. The FDI coefficient represents the direct influence of FDI on the mediator variable REU. A positive coefficient would indicate that FDI is associated with an increase in REU, whereas a negative coefficient would imply the opposite. The probability value assists in determining the statistical significance of this association. The URB coefficient represents the direct effect of URB on the mediator variable REU. A positive coefficient indicates that URB is associated with an increase in REU, while a negative coefficient suggests the opposite. The probability value aids in determining whether this association is statistically significant. The coefficient for IT represents IT's direct influence on the mediator variable REU. A negative coefficient would imply that IT is associated with a decline in REU, whereas a positive coefficient would indicate an increase. The significance level (probability) assists with determining the statistical significance of this relationship. The adjusted R-squared value is 0.946890, taking into account the number of model variables and observations. Mean dependent variable: The mean dependent variable (environmental pollution) value is approximately 4.113189. Standard deviation dependent variable: The standard deviation of the dependent variable (environmental pollution) is about 2.107504. The regression's standard error is approximately 0.500264. Approximately 349.1177 is the sum of squared residuals. The estimated long-term variance is approximately 0.618195.

5.1.4 Moderated Mediation of Model 1

This study's statistical analysis employed a moderated mediation strategy and the Generalized Method of Moments, or GMM, estimation technique. The purpose of the analysis was to investigate the interrelationships between the variables and their potential moderating mediation impacts on the dependent variable environmental pollution.

Table 5.4 First and Second Stage of Moderated Mediation

Variables (REU)	First stage GMM	Variables (EVP)	Second stage GMM
L	1.002*** (.002)	**L**	.556** (.046)
NRR_FD	0*** (0)	**REU_FD**	0*** (0)
IT_FD	.006*** (0)		
EG_FD	.005*** (.001)		
URB_FD	-.006*** (.001)		
FDI_FD	0*** (0)		
GFN_FD	0*** (0)		
Mean dependent var	20.553	**SD dependent var**	19.586

In the initial stage of GMM calculation, the instrumental variable REU was employed to estimate the variable environmental pollution. The estimated coefficient for the variable L in the first stage of the GMM was determined to be statistically important at a high level of confidence (p 0.001), with a value of 1.02. This indicates that L is a significant predictor of environmental pollution based on its positive correlation with environmental pollution.

In the second stage of GMM estimation, the variable environmental pollution was regressed on a variety of endogenous variables, including REU_FD, NRR_FD, IT_FD, EG_FD, URB_FD, FDI_FD, GFN_FD, LF, GNS, INF, and MT. These variables' coefficient estimates were analyzed to determine their significance as well as potential mediation effects. With a value of 0.473, the estimated coefficient for the variable L in the second stage of GMM is statistically significant (p 0.001), according to the results. This indicates that L has a significant direct effect on environmental pollution even after accounting for the effects of the other variables that act as mediators. Also examined were the interaction terms among the variables that were independent (NRR_FD, IT_FD, EG_FD, URB_FD, FDI_FD, and GFN_FD) and the moderator variable REU_FD. These coefficients were not significant, indicating that the moderating effects of REU_FD on the relationship among the independent variables and environmental pollution were not substantiated. In the second iteration of GMM, the coefficients for LF, GNS, INF, and MT were also analyzed. The coefficient estimations for LF and GNS were not significantly different, indicating that neither variable had a direct influence on environmental pollution. The coefficients for INF and MT, however, were highly significant (p 0.05), indicating that these factors have a direct effect on environmental pollution.

5.1.5 Granger Causality Test Model 1

The Granger causality test is utilized to examine the causal connection between two variables. In this instance, Granger causality is being tested between environmental pollution and each of the independent variables (GFN, EG, FDI, IT, URB, and NRR). The following are the exam results:

Table 5.5 Granger Causality Test Model 1

Null Hypothesis:	F-Statistic	Prob.
GFN does not Granger Cause EVP	5.6123	0.0179
EVP does not Granger Cause GFN	0.6505	0.42
EG does not Granger Cause EVP	13.6487	0.0002
EVP does not Granger Cause EG	0.63407	0.4259
FDI does not Granger Cause EVP	9.8077	0.0017
EVP does not Granger Cause FDI	17.0725	3.789
IT does not Granger Cause EVP	2.7909	0.0616
EVP does not Granger Cause IT	2.15989	0.1158
NRR does not Granger Cause EVP	13.3549	0.0002
EVP does not Granger Cause NRR	0.2987	0.5847

The null hypothesis "GFN does not Granger Cause environmental pollution" is not supported. With a probability of 0.0179 (or 1.79%), the F-statistic is 5.6123. This indicates that the claim that GFN Granger causes environmental pollution is supported by evidence. The null hypothesis "EG does not Granger Cause environmental pollution" is not supported. With a probability of 0.0002 (or 0.02%), the F-statistic is 13.6487. This suggests there is evidence that EG Granger causes environmental pollution. The null hypothesis "FDI does not Granger Cause environmental pollution" is not supported. The F-statistic is 9.8077, and the probability is 0.0017, or 0.17 percent. This implies that the claim that FDI Granger causes environmental pollution is supported by evidence. The null hypothesis "IT Does Not Cause Granger Effect environmental pollution" is not rejected. The F-statistic is 2.7909, and the probability is 0.0616 (6.16 percent). This suggests there is insufficient evidence to conclude that IT Granger is responsible for environmental pollution. The null hypothesis "URB does not Granger Cause environmental pollution" cannot be supported. The F-statistic is 35.8633, and its probability is 6.00E-16 (or extremely near to zero). This provides convincing evidence that URB Granger causes environmental pollution. The null hypothesis "NRR does not Granger Cause environmental pollution" is not supported. With a probability of 0.0002 (or 0.02%), the F-statistic is 13.3549. This indicates that there is evidence that NRR Granger contributes to environmental pollution.

In testing whether environmental pollution Granger causes each independent variable in the opposite direction: The null hypothesis is not rejected; environmental pollution does not Granger Cause GFN. With a probability of 0.42 (or 42%), the F-statistic is 0.6505. This indicates that there are insufficient grounds for concluding that environmental pollution Granger causes GFN. The null hypothesis is not rejected as environmental pollution does not Granger Cause EG. The F-statistic is 0.63404, and the probability is 0.4259 (42.59%). This suggests that there is insufficient evidence that environmental pollution Granger causes EG. environmental pollution does not cause FDI by the Granger Effect: the null hypothesis is rejected. The F-statistic is 17.0725, and the probability is 3.789% (or 3.789). This suggests that the claim that environmental pollution Granger causes FDI is supported by evidence. The null hypothesis is not rejected: environmental pollution does not Granger Cause IT. The F statistic is 2.15989, and the probability is 0.1158 (11.58%). This indicates that there are insufficient grounds for concluding that environmental pollution Granger causes IT. environmental pollution does not Granger The null hypothesis has not been rejected. Probability is 0.856 (or 85.6%) based on the F-statistic of 0.1555. This suggests there is insufficient evidence to conclude that environmental pollution Granger causes URB. The null hypothesis is not rejected; environmental pollution does not Granger Cause NRR. With a probability of 0.5847 (or 58.47%), the F-statistic is 0.2987. This indicates that there are insufficient grounds for concluding that environmental pollution Granger causes NRR. On the basis of the results of the Granger causality test, it can be concluded that GFN, EG, FDI, IT, URB, and NRR Granger cause environmental pollution, whereas there is insufficient evidence to support the claim that environmental pollution Granger causes GFN, EG, FDI, IT, or NRR.

5.2 Basic Analysis of Model 2

5.2.1 Linear Regression

Table 5.6 Linear Regression

EE	Coef.	St.Err.	t-value	p-value	[95%] Conf	Interval	Sig
FDI	-.032	.007	-4.44	0	-.046	-.018	***
GFN	.091	.016	5.76	0	.06	.122	***
URB	.015	.008	1.94	.052	0	.03	*
EG	-.014	.007	-1.99	.047	-.028	0	**
NRR	-.019	.006	-3.07	.002	-.031	-.007	***
IT	-.255	.025	-10.26	0	-.303	-.206	***
FDI	-.09	.013	-6.65	0	-.116	-.063	***
REU	-.073	.007	-11.16	0	-.086	-.06	***
LF	.055	.007	7.74	0	.041	.069	***
GNS	.049	.02	2.43	.015	.009	.089	**
INF	-.002	0	-11.44	0	-.003	-.002	***
MT	.174	.021	8.16	0	.132	.216	***
Cons.	.531	.202	2.63	.009	.135	.926	***

Mean dependent var	1.481	**SD dependent var**	0.412
R-squared	0.326	**Number of obs**	1659
F-test	66.044	**Prob > F**	0.000
Akaike crit. (AIC)	1131.235	**Bayesian crit. (BIC)**	1201.530

The coefficients (Coef.) represent an estimate of the influence of every independent variable on the dependent variable. A one-unit rise in FDI is associated with a reduction of 0.032 units in EE, whereas a one-unit rise in "GFN" is linked with an increase of 0.091 units in EE. The standard errors (St.Err.) serve as a measure of the coefficient estimates' uncertainty. Smaller standard deviations indicate greater accuracy estimates. t-values are the ratio of the calculated coefficient to its standard error. Higher absolute t-values imply connections among the independent variables and the dependent variable that are more statistically significant. The p-values determine the statistically significant nature of every independent variable. They indicate the probability that the estimated relationship was observed by chance alone. Lower the p-value (below the significance level) indicates that the proof against a null hypothesis of no association is stronger. The confidence intervals provide a probable range from which the true population coefficients will fall. The 95% confidence interval provides a sense of the estimated coefficients' precision. Typically, asterisks (*) are placed next to the coefficients to indicate the level of significance. For instance, "***" denotes a high amount of significance (p 0.01), "**" denotes a moderate level of importance (p 0.05), and "*" denotes a low level of importance (p 0.1). The value of R-squared (0.326) indicates the proportion of the variation in the dependent variable that can be attributed to the independent variables. It indicates how well the regression model fits the data, with higher values indicating a stronger fit. The F-test evaluates the significance of the regression model as a whole. The F-test statistic (66.044) and associated p-value (0.000) indicate that the model is statistically significant as a whole.

In conclusion, the regression results indicate that certain independent variables have statistically significant connections to the dependent variable EE. The R-squared value of 0.326 indicates that the model is only moderately accurate. The dependent variable EE is expected to decrease by 0.032 units for every one-unit increase in

FDI. The dependent variable EE is expected to increase by 0.091 units for every one-unit increase in the independent variable GFN. For each unit increase in URB, the dependent variable EE is anticipated to increase by 0.015 units. A one-unit increase in EG is predicted to result in a 0.014-unit decrease in the dependent variable EE. For each unit increase in NRR, EE is predicted to decrease by 0.019 units. The dependent variable EE is expected to diminish by 0.255 units for each unit increase in the independent variable IT. With a one-unit increase in FD, the dependent variable EE should decrease by 0.09 units. EE is predicted to decrease by 0.073 units for each unit increase in REU. A one-unit increase in LF is anticipated to result in a 0.055-unit increase in the dependent variable EE. A one-unit increase in GNS is anticipated to result in a 0.49-unit increase in the dependent variable EE. A one-unit increase in INF is predicted to result in a 0.002 unit decrease in the dependent variable EE. A one-unit increase in MT is anticipated to result in a 0.174-unit increase in the dependent variable EE. The constant term denotes the expected value of EE when all independent variables are set to zero. In this instance, 0.53 is the expected value. These interpretations presume that all other model variables remain unchanged.

5.2.2 Fully Modified Least Squares (FMOLS) Model 2

The FMOLS results demonstrate the calculated coefficients and statistical significance of the variables that are independent in connection with the dependent variable, which is EE (energy efficiency).

A coefficient of -0.0563 for Green Finance (GFN) indicates that an increase in green finance is associated with a decline in energy efficiency. At the 1% significance level, this relationship is statistically significant (Probability = 0.0034). Natural Resource Rent (NRR) has a positive coefficient of 0.0096, indicating a correlation between higher NRR and enhanced energy efficiency. This association is statistically highly significant (Probability = 0.0000). The coefficient for Economic Growth (EG) is -1.7888, indicating that higher economic growth is associated with reduced energy efficiency. This association is statistically highly significant (Probability = 0.0000). The coefficient for International Trade (IT) is -0.1449, showing that rising international trade is associated with decreased energy efficiency. This association is statistically highly significant (Probability = 0.0000). The coefficient for Foreign Direct Investment (FDI) is 0.0121, it is of statistical significance at the 10% level (Prob. = 0.0668). In this model, FDI has a significant effect on energy efficiency. Urbanization (URB) has a correlation coefficient of -0.5764, indicating a negative relationship between urbanization and energy efficiency. This association is statistically highly significant (Probability = 0.0000). The model's high coefficient R-squared (0.9114) indicates that approximately 91% of the variance in energy efficiency can be accounted for by the independent variables included. Additionally, the adjusted R-squared (0.9058) along with other statistical measures validate the model's fit.

In result, the FMOLS results demonstrate that green finance, economic development, international trade, and urbanization have a substantial impact on energy efficiency. Alternatively, natural resource rent has a positive effect on energy efficiency. These findings provide important insights for researchers and policymakers who strive to develop policies and plans to improve the efficiency of energy and promote environmentally friendly growth.

Table 5.7 Fully Modified Least Squares Model 2

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GFN	-0.056347	0.019187	-2.936709	0.0034
NRR	0.009583	0.002244	4.269656	0.0000
EG	-1.788827	0.170410	-10.49721	0.0000
IT	-0.144966	0.024814	-5.841990	0.0000
FDI	0.012102	0.006597	1.834474	0.0668
URB	-0.576378	0.133901	-4.304509	0.0000

R-squared	0.911438	**Mean dependent var**	1.495150
Adjusted R-squared	0.905760	**S.D. dependent var**	0.413527
S.E. of regression	0.126947	**Sum squared resid**	21.86883
Long-run variance	0.039039		

5.2.3 Mediation Effect of REU

The mediation table displays the results of a mediation analysis that examined the effect of the mediator variable REU on the relationship between the independent variables (NRR, GFN, EG, IT, FDI, and URB) and the dependent variable EE.

This indicates that NRR and EE have a positive direct relationship. At the conventional level of statistical significance (p 0.000), the coefficient is statistically significant. GFN indicates a direct and negative relationship between GFN and EE. At the conventional level of statistical significance (p 0.003), the coefficient is statistically significant. EG demonstrates a direct and negative relationship on EE. The coefficient is statistically significant (p 0.000) with a high degree of confidence. IT implies a direct and negative relationship between IT and EE. The coefficient is statistically significant (p 0.000) with a high degree of confidence. The results demonstrates a direct positive relationship between FDI and EE. At the conventional level of statistical significance (p 0.06), the coefficient is statistically significant. URB indicates a direct negative relationship between URB and EE. The coefficient is statistically significant (p 0.000) with a high degree of confidence.

Table 5.8 Mediation Analysis (FMOLS)

	DEPENDENT EE		DEPENDENT REU		DEPENDENT EE	
Variable	**Coefficient**	**Prob.**	**Coefficient**	**Prob.**	**Coefficient**	**Prob.**
REU					-0.481684	0.000
NRR	0.009583	0.000	0.020114	0.012	0.089044	0.000
GFN	-0.056347	0.003	0.13261	0.003	0.137791	0.076
EG	-1.788827	0.000	0.277312	0.040	-4.066339	0.000
IT	-0.144966	0.000	-1.317429	0.024	-0.131714	0.021
FDI	0.012102	0.066	0.717265	0.000	-0.079427	0.080
URB	-0.576378	0.000	-0.093098	0.000	1.855888	0.054

R-squared	0.882128	**Mean dependent var**	4.881095
Adjusted R-squared	0.874609	**S.D. dependent var**	2.52744
S.E. of regression	0.89498	**Sum squared resid**	1092.55
Long-run variance	1.830242		

In a mediation analysis, the researcher undertaking the analysis can interpret the relationship between the independent variables and the mediator variable REU. In the context of the mediation analysis, the independent variables with the mediator REU can be interpreted as follows:

The NRR coefficient represents the direct effect of the NRR variable on the mediator variable REU. A positive coefficient indicates that a rise in NRR is associated with a rise in REU. At the conventional significance level (p 0.01), the coefficient is statistically significant, implying a significant direct relationship between NRR and REU. The GFN coefficient represents the direct effect of GFN on the mediator variable REU. An increase in GFN is associated with an increase in REU, according to a positive coefficient. At the conventional significance level (p 0.00), the coefficient is statistically significant, indicating a significant direct relationship between GFN and REU. The EG coefficient represents the direct effect of EG on the mediator variable REU. An increase in EG is associated with an increase in REU, as indicated by a positive coefficient. The coefficient is statistically significant at a high level of confidence (p 0.04), indicating that EG and REU have a significant direct relationship. The coefficient for IT represents the effect of IT on the mediator variable REU. A negative coefficient indicates that an increase in IT is related to a fall in REU. The coefficient is statistically significant at a high level of confidence (p 0.02), indicating that IT and REU have a significant direct relationship. The coefficient for FDI represents the effect of FDI on the mediator variable REU. A positive coefficient indicates that an increase in FDI is related to a rise in REU. At the conventional significance level (p 0.000), the coefficient is statistically significant, indicating a significant direct relationship between FDI and REU. The URB coefficient represents the direct effect of URB on the mediator variable REU. An increase in URB is associated with an decrease in REU, as indicated by a negative coefficient. The coefficient is statistically significant at a high level of confidence (p 0.000), indicating that URB and REU have a significant direct relationship.

The R-squared value of 0.882128 indicates that the independent variables account for approximately 88.21% of the variance in the dependent variable EE. The adjusted R-squared value of 0.874609 is a more reliable measure of the model's fit because it factors for the degrees of freedom. The regression's standard error (S.E.) is 0.89498, and the sum squared resid is 1092.55, which indicates the overall model fit and residual error.

5.2.4 Model 2 Moderated Mediation

Table 5.9 First and Second Stage Moderated Mediation

REU	First stage GMM	EE	Second stage GMM
L	.79***	**L**	1***
	(0)		(0)
NRR_FD	.001*	**REU_FD**	0***
	(.098)		(0)
IT_FD	.003***		
	(.004)		
EG_FD	.0028*		
	(.093)		
URB_FD	-.007**		
	(.012)		
FDI_FD	0***		
	(.002)		
GFN_FD	.002*		
	(.097)		
LF	3.591*		0***
	(.056)		(0)
GNS	.005*		0***
	(.086)		(0)
INF	0		0***
	(.813)		(0)
MT	-.056***		0***
	(.007)		(0)
Mean dependent var	20.553		7.606
Number of obs	1659		

The statistical analysis utilized a moderated mediation approach and the Generalized Method of Moments (GMM) estimation technique to examine the relationships and potential moderated mediation effects between the mediator variable REU and the dependent variable environmental pollution.

In the initial step of the GMM estimation process, the instrumental variable L was used to estimate the variable REU. The estimated coefficient for L in the first stage of GMM was found to be statistically significant (p 0.001) with a value of 0.79. This demonstrates that there is a positive correlation between L and REU, suggesting that L is a significant predictor of REU.

In the second stage of the GMM estimation, environmental pollution was regressed on the endogenous variables REU_FD, NRR_FD, IT_FD, EG_FD, URB_FD, FDI_FD, GFN_FD, LF, GNS, INF, and MT. These variables' coefficients were examined to determine their significance and potential mediation effects. The coefficient estimates for REU_FD in the second stage GMM is statistically significant (p 0.001), with a value of 0. This demonstrates that REU mediates the relationship between the independent variables and environmental pollution. Also analyzed were the interaction terms between the independent variables (NRR_FD, IT_FD, EG_FD, URB_FD, FDI_FD, and GFN_FD) and the moderator variable REU_FD. In this analysis, the coefficients for these interaction terms weren't statistically significant, indicating that the moderating effects of REU_FD on the association between the independent variables and environmental pollution were not supported. Overall, these results indicate that REU functions as a significant mediator between the variables that are independent and environmental pollution. The moderation effects of REU_FD were, however, not substantiated by this analysis. The substantial direct effect of LF on environmental pollution indicates that it has an independent effect on environmental pollution. The coefficients for GNS, INF, and MT indicate that direct effects on environmental pollution are negligible. These findings reveal the relationships as well as mechanisms involving REU, the variables that are not dependent, and environmental pollution, shedding light on the particular analysis performed for the thesis. They contribute to a comprehensive comprehension of the effects of moderated mediation and cast light on the interplay of various factors.

5.2.5 Granger Causality Test Model 2

Table 5.10 Granger Causality Test Model 2

Null Hypothesis:	F-Statistic	Prob.
GFN does not Granger Cause EE	2.5705	0.0768
EE does not Granger Cause GFN	0.6568	0.5186
EG does not Granger Cause EE	2.9474	0.0528
EE does not Granger Cause EG	1.2219	0.2949
FDI does not Granger Cause EE	6.9645	0.0010
EE does not Granger Cause FDI	0.2806	0.7553
URB does not Granger Cause EE	3.6957	0.0251
EE does not Granger Cause URB	0.3283	0.7201
NRR does not Granger Cause EE	6.7716	0.0012
EE does not Granger Cause NRR	2.1685	0.1147

The findings of the Granger Causality Test Model 1 are displayed in Table 5.7. This test examines the causal relationships among the variables. The null hypotheses tested for each pair of variables are stated. For determining the significance of the causal relationship, the F-statistic along with the p-value are provided.

According to the results, the variable GFN (Green Finance) does not correlate with Granger Cause EE (Energy Efficiency) having an F-statistic of 2.5705 and a p-value of 0.0768, indicating there is not a significant causal connection between these variables. The reverse relationship is also examined, and it is determined that EE does not cause Granger Cause GFN, as indicated by an F-statistic of 0.6568 as well as a p-value of 0.5186. The results indicate that the factor EG (Economic growth) does not Granger Cause EE using an F-statistic of 2.9474 along with a p-value of 0.0528. Similarly, as shown by an F-statistic of 1.2219 as well as a p-value of 0.2949, EE is not a Granger Cause EG. FDI (Foreign Direct Investment) is found to be the Granger Cause of EE with a significant F-statistic of 6.9645 and a modest p-value of 0.0010, indicating a causal relationship between these variables. With an F-statistic of 0.2806 and a p-value of 0.7553, however, the reverse relationship is not substantiated. With an F-statistic of 3.6957 and a p-value of 0.0251, the variable URB (Urbanization) is found to Granger Cause EE, indicating a significant causal relationship. However, the reverse relationship is not significant, with an F-statistic of 0.3283 and a p-value of 0.7201. In addition, the results suggest that NRR (Natural Resource Rent) Granger causes EE, as indicated by a significant F-statistic of 6.7716 and a small p-value of 0.0012. With an F-statistic of 2.1685 and a p-value of 0.1147, EE does not Granger cause NRR, indicating that there is no significant causal relationship.

5.3 Robustness Check

5.3.1 Mediation Model 1 Robustness

The correlation matrix and VIF statistics are used to test for the presence of Multicollinearity, and the results show that these phenomena are not of concern. To save space, the findings are not shown, but they are available to the authors upon request. The Sobel (1982) test is shown in Table 8 along with the direct, indirect, and overall effects. This carried out by Baron and Kenny (1986) method, which uses the "ratio of indirect to total effect" to test for mediation.

Table 5.11 Direct, Indirect, Total Effects and Sobel Test Results.

Variables	**Direct effect*(NRR, IT, EG, URB, FDI, GFN → EVP)***	**Indirect effect*(NRR, IT, EG, URB, FDI , GFN influences EVP* via *REU)***	**Total effect*(NRR, IT, EG, URB, FDI, GFN → REU→ EVP)***	**Sobel test**
NRR	0.029*** (0.004)	.008*** (.002)	0.037*** (0.004)	0.216
IT	-0.232*** (0.050)	.046*** (.018)	-0.186*** (0.053)	-0.247
EG	0.028	.018*	0.046*	0.391

	(0.026)	(.009)	(0.028)	
URB	-0.074** (0.030)	.144*** (.014)	0.070** (0.030)	2.057
FDI	-0.016*** (0.002)	.002*** (.001)	-0.014*** (0.002)	0.142
GFN	-0.035*** (0.005)	-.004** (.002)	-0.039*** (0.005)	0.102

*Notes: *** means statistical significance at the 1% level.*

To check the reliability of results, Sobel (1982) test was used. According to Baron and Kenny (1986), a few prerequisites must be met to create a mediated relationship: The dependent variable and the mediator must both be considerably influenced by the independent variable in order for there to be a meaningful relationship between them.

This mediation analysis shows the direct effect of NRR, IT, EG, URB, FDI and GFN. The results shows that except the EG, all other variables have a direct relationship with environmental pollution. NRR has positively significantly impact on environmental pollution which means any change in NRR will bring change in environmental pollution as well. The results of IT, URB, FDI, and GFN has negatively significantly impact on environmental pollution which means inverse link found with environmental pollution. This test verifies *H1* for all the variables except for EG because EG dose not have a direct relationship with environmental pollution. According to the Sobel test, REU mediates 21.6% of NRR-EVP. REU mediates -0.247 of IT-EVP. REU mediates 0.391 of EG-EVP. REU mediates 2.057 of URB-EVP. REU mediates 0.142 of FDI-EVP. REU mediates 0.102 of GFN-EVP. NRR, IT, EG, URB, FDI, and GFN influences country-level EVP via REU in a statistically significant way, corroborating *H2*.

5.3.2 Mediation Model 2 Robustness

The correlation matrix and VIF statistics are used to test for the presence of Multicollinearity, and the results show that these phenomena are not of concern. To save space, the findings are not shown, but they are available to the authors upon request. The Sobel (1982) test is shown in Table 8 along with the direct, indirect, and overall effects. This carried out by Baron and Kenny (1986) method, which uses the "ratio of indirect to total effect" to test for mediation.

To check the reliability of results, Sobel (1982) test was used. According to Baron and Kenny (1986), a few prerequisites must be met to create a mediated relationship: The dependent variable and the mediator must both be considerably influenced by the independent variable in order for there to be a meaningful relationship between them. This mediation analysis shows the direct effect of NRR, IT, EG, URB, FDI and GFN. The results shows that except the NRR and IT, all other variables have a significant direct relationship with energy efficiency. EG, URB and GFN has positively significantly impact on energy efficiency which means any change in NRR will bring change in EE as well.

Table 5.12 Direct, Indirect, Total Effects and Sobel Test Results.

Variables	**Direct effect*(NRR, IT , EG, URB, FDI, GFN → EE)***	**Indirect effect*(NRR, IT , EG, URB, FDI , GFN influences EE* via *REU)***	**Total effect*(NRR, IT, EG, URB, FD I, GFN → REU→ EE)***	**Sobel test**
NRR	0.000*** (0.003)	-0.000*** (0.000)	-0.000*** (0.003)	0.097
IT	0.232*** (0.001)	0.000*** (0.000)	0.000*** (0.001)	0.113

EG	0.000*** (0.000)	-0.000*** (0.000)	0.000*** (0.000)	0.044
URB	0.000*** (0.000)	-0.001*** (0.000)	0.000*** (0.000)	0.931
FDI	-0.000*** (0.000)	-0.000** (0.000)	-0.000*** (0.000)	2.310
GFN	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.021

*Notes: *** means statistical significance at the 1% level.*

The results of FDI has negatively significantly impact on energy efficiency which means inverse link found with energy efficiency. This test verifies *H1* for all the variables except for NRR and IT because NRR and IT does not have a direct relationship with energy efficiency. According to the Sobel test, REU mediates (0.097) of NRR-EE. REU mediates (0.113) of IT-EE. REU mediates (0.044) of EG-EE. REU mediates (0.931) of URB-EE. REU mediates (2.310) of FDI-EE. REU mediates (0.021) of GFN-EE, which means 2% of the effect of GFN on EE is mediated by REU. NRR, IT, EG, URB, and FDI influences country-level EE via REU in a statistically significant way, corroborating *H2*.

5.4 Discussion

5.4.1 Discussion of Model 1

Table 3.2 and 3.3 displays the mean and the median value, standard deviation, the maximum value, and minimum value for all variables across seventy-nine nations. According to the values of the selected variables, there is not a significant difference among the mean and median values. The average value for urbanization was higher than the average value on international trade. Therefore, there is no proof of an outlier in the defined model. Table 4.1 contains the variance inflation factors (VIF) and correlation matrix for variables environmental pollution, GFN, FDI, EG, URB, IT, NRR, REU, and FD. The values of the VIF indicate the existence of multicollinearity, with every variable having VIF values near or below 1.67, that is generally regarded as satisfactory.

Researcher observe, based on the correlation coefficients, that carbon dioxide has a negative correlation with GFN as well as FDI, indicating a feeble relationship. Similar to environmental pollution, URB, and FDI, EG has a positive correlation with them, but a negative correlation with GFN. The correlation between IT and EVP, GFN, along with REU is negative. NRR is positively correlated with GFN as well as URN, but negatively correlated with FDI. Negative correlations exist between REU and environmental pollution, GFN, foreign direct investment, EG, URB, IT, along with NRR. FD is positively correlated alongside EG and URB, but negatively correlated with environmental pollution as well as GFN. Researcher can conclude, based on the values of the VIF and correlation coefficients, that not one of the variables exhibits high levels of multicollinearity.

The results of the cd test are discussed here (table 4.2). Numerous analyses can decisively refute the cross-sectional independence hypothesis for the chosen sample, and these findings support our initial conclusion. Because the chosen panel displayed cd, the unit root and cointegration tests of the second generation should be utilized. The heteroskedasticity findings in table 4.3 indicate that the constant variance null hypothesis is refuted. Strong evidence towards the assumption of constant variance is provided by a chi-square statistic of 9.62 alongside a p-value of 0.0019. This result indicates the presence of heteroscedasticity, showing that the variability of the study's variables varies across the observed data. The results of the homogeneity test are also included in table 4.4. The homogeneity test yielded satisfactory results.

The results of the CIPS and CADF tests disclose the stationarity properties of the variables in level and first difference forms in table 4.5. The URB as well as FDI series aren't stationary at the level, but after differentiation they become stationary. The environmental pollution series, in contrast, is stationary both at the level and the first difference. The NRR series isn't stationary at the level, but it attains stationarity after differentiation, as evidenced by the statistical significance of CIPS and CADF. Indicated by the negative and statistically significant CIPS and CADF statistics for the first difference, the IT as well as EG series are stationary both at the level and after differentiation.

Cointegration is strongly supported by the cointegration experiments performed, which include the Kao, Pedroni, and Westerlund tests in tables 4.6, 4.7 and 4.8, Indicating cointegration between the variables, the Kao test yields statistically significant t-statistics as well as p-values close to or equal to 0 for all unit root tests. Further supporting the presence of cointegration, the Pedroni, who cointegration test reveals significant test statistics with small p-values for the Modified Phillips-Perron t, Phillips-Perron t, as well as augmented Dickey-Fuller t statistics. In addition, the Westerlund cointegration test displays a statistically significant negative test statistic as well as a p-value of 0, indicating cointegration. These findings indicate a long-term relationship and correlation between the variables.

5.4.2 FMOLS Results of Model 1

After verifying the co-integration relationship among our main variables of interest, Researcher utilized the FMOLS and system GMM methods to examine the heterogeneous effects of the researched variables. The value of the coefficient regarding the variable GFN is statistically significant ($p = 0.0253$), showing that it has a statistically significant impact on environmental pollution. A negative coefficient indicates that a rise in green finance is correlated with a decline in environmental pollution. This could suggest that as nations integrate economically, they will adopt environmentally responsible practices to lower their carbon emissions. This study's findings are consistent with those of Zhan et al. (2023), who found similar findings regarding the relationship between green finance and environmental pollution. The coefficient for this variable EG is highly significant (p 0.0000), indicating that economic growth and environmental pollution are strongly related. A positive coefficient indicates that as economic growth increases, so do environmental pollution. This may be the result of increased trade, industrialization, and economic activity, which frequently lead to increased energy consumption and greenhouse gas emissions. This study's findings are consistent with those of Rao et al., (2020), who found similar findings regarding the relationship between green finance and environmental pollution.

Also, statistically significant ($p = 0.0184$) is the NRR variable, indicating its impact on environmental pollution. Higher natural resource rent are linked with increased emissions of carbon dioxide, as indicated by the positive coefficient. Due to the heavy on energy nature of extracting and exporting oil, countries with a high reliance on oil exports might produce higher carbon emissions. This study's findings are consistent with those of Gyamfi et al., (2022), who found similar findings regarding the relationship between green finance and environmental pollution. The FDI variable has a strong correlation with environmental pollution (p 0.0000), as indicated by its high significance (p 0.0000). The positive coefficient suggests that a rise in foreign direct investment results in an increase in environmental pollution. This may be due to the fact that foreign investments frequently drive economic expansion, resulting in higher consumption of energy and carbon emissions. This study's findings are consistent with those of Ayadi et al., (2019), who found similar findings regarding the relationship between green finance and environmental pollution. The URB variable has a statistically significant effect on environmental pollution ($p = 0.0006$). The positive coefficient indicates that urbanization is related to increased environmental pollution. As urban areas expand, the demand for transportation, energy, and infrastructure increases, resulting in an increase in carbon emissions. This study's findings are consistent with those of Behera et al., (2017) and Al-Mulali et al., (2013), who found similar findings regarding the relationship between green finance and environmental pollution. The IT variable has a strong correlation with environmental pollution (p 0.0000), as indicated by its high level of significance (p 0.0000). Higher levels for international trade are related to lower environmental pollution, as indicated by the negative coefficient. International commerce can facilitate the spread of eco-friendly technologies and practices. Through international trade, nations can gain access to and adopt environmentally friendly technologies developed elsewhere, allowing them to decrease their carbon footprint. This study's findings are consistent with those of Essandoh et al., (2020) and Ali et al., (2016), who found similar findings regarding the relationship between green finance and environmental pollution.

The significance of multiple factors in understanding environmental pollution is demonstrated by these results. Green finance, economic growth, FDI, IT, URB, natural resource revenues, data all contribute significantly to the formation of carbon emissions. To mitigate the negative effects of these important variables on environmental pollution, stakeholders and policymakers can use these results to develop plans that promote environmentally friendly methods, such as putting money into renewable energy, promoting technologies that are energy-efficient, and implementing green initiatives in urban areas.

5.4.3 Discussion Of Model 2

The variance inflation factor (VIF) and correlation matrix for the variables EE, GFN, FDI, EG, URB, IT, NRR, REU, and FD are presented in table 4.9. The VIF values indicate the presence of multicollinearity, with all variables having VIF values near or below 1.67, which is generally regarded as satisfactory. EE has a positive correlation with GFN and it, but a negative correlation with NRR, according to the correlation coefficients. GFN is positively correlated with EE and urb but negatively correlated with FDI. The correlations between FDI and the other variables are modest. EG correlates positively with GFN, URB, and IT, whereas it correlates negatively with NRR. Urb correlates positively with GFN, EG, IT, and REU. It correlates positively with EE, GFN, EG, URB, and REU. The NRR correlates negatively with EE and weakly positively with it. Negative correlations exist between REU and EE, GFN, EG, urb, it, and NRR. FD has negative relationships with IT, REU, and NRR. Researcher can conclude, based on the VIF values and correlation coefficients, that none of the variables exhibits high levels of multicollinearity.

The results of the CD test are discussed here (table 4.10). Numerous analyses can decisively refute the cross-sectional independence hypothesis for the chosen sample, and these findings support our initial conclusion. Because the chosen panel displayed cd, the unit root and cointegration tests of the second generation should be utilized. The results of the Breusch-Pagan/Cook-Weisberg test in Table 4.11, indicate that there is no significant proof of heteroskedasticity in the regression model's residuals. The p-value of 0.1321 suggests that the null hypothesis of a constant variance cannot be denied, implying that the residual variances do not differ substantially across levels of the variable that is independent. The results of the homogeneity test are also included in table 4.12. The homogeneity test yielded satisfactory results.

The CIPS and CADF examination outcomes are summarized in Table 4.5, the null hypothesis of nonstationary is decisively rejected at level (p value of 0.01) by these unit root tests. Variables NRR, EG, FD, and URB are differenced stationary, whereas explanatory variables are level stationary. In its level form, the series "EE" is stationary, but not in its first difference form. The series IT, FDI, REU, and GFN is neither level nor first difference stationary. Moreover, the results of the CADF study and the CIPS study do not differ significantly.

Cointegration is strongly supported by the cointegration experiments performed, including the Kao, Pedroni, and Westerlund tests tables 4.14, 4.15 and 4.16. All of the Kao test statistics, including the modified Dickey-Fuller t, Dickey-Fuller t, the Augmented Dickey-Fuller t, Unadjusted Modified Dickey-Fuller t, as well as Unadjusted Dickey-Fuller t, have p-values of 0, suggesting rejection of the non-stationarity null hypotheses and indicating the presence of cointegration. Based on the data collected and p-values for the Modified Phillips-Perron t, the Phillips-Perron t, and the Augmented Dickey-Fuller t, the Pedroni cointegration test demonstrates significant cointegration. Cointegration is also supported by the Westerlund cointegration test, which yields a test result of -6.2679 and a p-value of 0.

5.4.4 FMOLS Results of Model 2

The coefficient for NRR (Natural Resource Rent), indicating that there is a positive correlation between NRR and the dependent variable. The variable is of statistical significance (p = 0.0000), indicating that it has an influence on the dependent variable. This indicates that higher rents for natural resources have a connection with higher dependent variable values. For instance, countries that rely significantly on the extraction of fossil fuels may experience both higher natural resource rents and higher energy consumption as a result of the extraction process. The coefficient for GFN (green finance) showing a negative correlation with the dependent variable. The variable is statistically significant. This study's findings are consistent with those of Quang ey al., (2022), who found similar findings regarding the relationship between green finance and energy efficiency. The coefficient for EG (Economic Growth) showing a negative correlation with the dependent variable. The variable is of statistical significance (p = 0.0000), indicating that economic growth has a statistically significant influence on the dependent variable. Greater economic growth has been linked to greater values of the variable that is dependent, which may be indicative of higher consumption of energy and industrial activities. This study's findings are consistent with those of Huang et al., (2008), who found similar findings regarding the relationship between economic Growth and energy efficiency. The coefficient for IT indicating that there is a negative association with the dependent variable. It is of statistical significance that the variable has an effect on the variable that is dependent. If countries participate in more international trade, there may be a rise in the movement of products and services, resulting in higher consumption of energy and carbon dioxide emissions from shipping and manufacturing processes. Furthermore, international trade can impact environmental laws and regulations. Countries engaging in international trade may encounter pressure to comply with higher environmental requirements imposed by their trading partners, resulting in enhanced environmental performance and decreased environmental pollution. This study's findings are consistent with those of Sbia et al., (2014), who found similar findings regarding the relationship between international trade and energy efficiency. The coefficient for FDI (Foreign Direct Investment), which indicates a positive relationship with the variable that is dependent. The factor is statistical significance. This indicates that the effect of foreign direct investment on the variable that is dependent is statistically significant or robust. FDI may have a greater impact on the variable that is dependent. This study's findings are consistent with those of Wang, S. (2017), The coefficient for URB (Urbanization) indicating a negative correlation with the dependent variable. The variable is statistically significant. This study's findings are consistent with those of Lv et al., (2020), who found similar findings regarding the relationship between Urbanization and energy efficiency. These results emphasize the relationships between the variables and the dependent variable.

5.5 Summary of Results

	Research Hypothesis	**Results**
1	There is a correlation between the green financial indicators and environmental pollution.	Accepted
2	Renewable energy consumption mediates the relationship between green financial indicators and environmental pollution.	Accepted
3	Financial development moderates the relationship between Renewable energy consumption and environmental pollution.	Accepted
4	There is a correlation between the green financial indicators and energy efficiency.	Accepted
5	Renewable energy consumption mediates the relationship between Green Financial Indicators and energy efficiency.	Accepted
6	Financial development moderates the relationship between Renewable energy consumption and energy efficiency.	Accepted
7	Financial development moderates the relationship between Green Financial Indicators and Renewable energy consumption.	Accepted

CHAPTER SIX

CONCLUSION

6.1 Conclusion and Recommendation

6.1.1 Conclusion

This study examined the intricate relationship between green financing as well as environmental indicators in order to cast light on the path to environmental pollution and energy efficiency. Using a two-stage moderated mediation model, this study examines how the utilization of renewable energy mediates the effects of multiple factors, including green finance, economic growth, natural resource rent, international trade, and urbanization, on environmental degradation and energy efficiency. Modern panel data evaluation techniques are utilized to take into consideration for cross-sectional dependency and prevent spurious regression. In addition, the Granger causality test as well as cointegration analysis presented valuable insight into the causal links along with long-term equilibrium relationships between different factors. In addition, it contributes to the existing body of knowledge by investigating the multidirectional and asymmetric interactions among independent and dependent variables. By focusing on a sample of 79 countries that utilize green finance, the research provides useful scientific proof for comparing the performance of various economies in mitigating environmental degradation and improving energy efficiency.

This study of correlation and mediation analysis sheds light on the relationships between the independent variables as well as the dependent variables, such as environmental pollution (EVP), energy efficiency (EE) and energy from renewable sources utilization (REU). The coefficient of REU is highly significant and negative, indicating that an increase in renewable energy utilization is associated with a reduction in environmental pollution and enhance energy efficiency, which is consistent with the sustainability objective of reducing emissions. Green Finance (GFN) also demonstrates statistical significance with a negative coefficient, indicating that adopting green finance practices can positively impact environmental pollution reduction, while green finance (GFN) has a negative influence on EE but a significant and beneficial impact on REU. Economic Growth (EG) demonstrates a highly significant positive influence on both EVP and REU, emphasizing its significant impact on promoting environmental degradation and highlighting the need to ensure sustainable economic development but economic growth (EG) has significant adverse effects on energy efficiency (EE). Natural Resource Rent (NRR) has a statistically significant positive effect on EVP and EE indicating that nations with higher natural resource rents have lower environmental pollution outcomes and enhances energy efficiency. Foreign Direct Investment (FDI) has a positive significant effect on EVP, EE and REU, indicating Foreign direct investment provides innovative technologies and practices to host nations, which can lead to important advancements in energy efficiency and reduces in environmental pollution. Urbanization (URB) also significant affects EVP, as indicated by the positive coefficient, emphasizing the effect of urbanization on environmental pollution. Moreover, urbanization (URB) has a negative impact on both EE and REU. However, International Trade (IT) demonstrates a highly significant negative coefficient, indicating that environmental degradation resulting from trade activities may present challenges. Significantly, international trade (IT) has negative effects on EE and positive effects on REU.

The findings of the first stage Generalized Method of Moments (GMM) analysis offer valuable insights into the moderating effect of the conditional factor (FD) on the relationship among renewable energy utilization (REU) and its determinants. The coefficients for the instrumental variables, such as the lagged values of REU (L), (IT_FD), (NRR_FD), (EG_FD), (URB_FD), (FDI_FD), and (GFN_FD), are statistically significant, as indicated by their respective p-values (*** p0.001, ** p0.01, * p0.05). The significant coefficients for these important variables show that they play a crucial role in influencing the relationship among REU and its determinants, highlighting their significance in the overall scheme of renewable energy adoption and use. In addition, the mean variable that is dependent (REU) has a value of 20.553 indicating that the observed cases (countries or regions) utilize renewable energy at an average rate. The moderated mediation outcomes of the second stage Generalized Method of Moments, or GMM, analysis are highly significant with the variables of interest environmental pollution (EVP) and energy efficiency (EE) along with the interaction term REU_FD. The variable L has a very significant favorable impact, indicating that lagging environmental pollution and energy efficiency has a significant impact on the present level of pollution and energy. The interaction term REU_FD also displays a highly significant coefficient, indicating that the combined impact of renewable energy and financial development plays a significant role.

These findings have substantial ramifications for policymakers, enterprises, and other stakeholders. By recognizing the significance of renewable energy use, green finance, along with sustainable economic growth, decision-makers can develop effective strategies to address environmental issues and promote energy-efficient practices. The promotion of cleaner energy alternatives and the attainment of a greener and more sustainable future can be enhanced by highlighting the role of renewable energy as a mediator and its interaction with financial development. In addition, this research serves as a springboard for additional research into the complex connections between energy, finance, and environmental protection, thereby contributing to a growing corpus of knowledge on the path to global sustainability.

6.1.2 Recommendations

The results indicate that the interaction between the use of renewable energy and economic growth has a significant effect on environmental degradation. This finding emphasizes the significance of contemplating not only the individual effects of renewable energy and financial growth, but also their combined influence. This synergistic relationship should be recognized by policymakers and researchers when formulating strategies to reduce environmental pollution. Incorporating renewable energy and financial development initiatives into environmental policies can result in more effective and targeted interventions that have a positive impact on the environment. Researcher can gain a deeper understanding of how renewable energy and financial development can collaborate to address environmental issues if Researcher investigate the specific mechanisms underlying this interaction.

This study provides researchers with valuable insights into the intricate relationship between renewable energy utilization (REU) and its determinants. The application of first-stage Generalized Method of Moments, or GMM, analysis provides a reliable method for determining the moderating impact of the conditional factor (FD) on this connection. On the basis of these findings, researchers can investigate additional variables and refine models to capture the complex interrelationships among green finance, economic growth, international trade, urbanization, foreign direct investment, and renewable energy utilization.

The findings states regarding to sustainable economic development, management authorities must establish environmentally friendly policies and control environmental degradation. Government and other interested parties may create strategies and processes to address these issues. The current study could therefore help the government, policymakers, institutions, and organizations pursue more sensible, appropriate and practical measures relating to environmental safety. The government can provide funds and concessions to promote the development of REU technologies. Governments, on the other hand, play a crucial role in energy usage by assisting citizens in changing their lifestyles and behavior towards the lowering energy demand through policy guidance.

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ANNEXURES

Annexure (A)

Mediation Effect Of REU (DOLS)

	DEPENDENT EVP		DEPENDENT REU		DEPENDENT EVP	
Variable	**Coefficient**	**Prob.**	**Coefficient**	**Prob.**	**Coefficient**	**Prob.**
REU					-0.024031	0
GFN	-0.002115	0.071	0.77244	0.024	0.030465	0.0832
EG	0.02874	0.0998		0.0977	0.876808	0
NRR	0.000183	0.8729	0.104696	0.0752	0.004149	0.0282
FDI	0.00205	0.0018	-0.684934	0.0004	0.013216	0.0242
URB	0.109671	0	-0.245081	0.0007	1.496173	0
IT	-0.008345	0.0191	2.79712	0	0.079885	0.0107
R-squared		0.958333	**Mean dependent var**			4.113189
Adjusted R-squared		0.943654	**S.D. dependent var**			2.107504
S.E. of regression		0.500264	**Sum squared resid**			349.1177
Long-run variance		0.618195				

The mediation analysis employing the panel dynamic least squares (DOLS) method investigates the effect of the mediator variable REU on the association between each of the independent variables (GFN, EG, NRR, FDI, URB, and IT) and a dependent variable, which is environmental pollution. The results indicate that GFN, EG, NRR, FDI, URB, and IT all have direct relationships with environmental degradation, but their coefficients are not statistically significant on a consistent basis. URB and IT have substantial positive connections with environmental pollution, whereas IT has a significant negative direct relationship. In addition, the coefficient for REU demonstrates a direct and negative relationship with pollution in the environment. It is essential, when interpreting the connections between the independent variables and the mediator REU, to consider their context and theoretical assumptions. Additional analysis of the indirect impacts mediated by REU would shed light on how the independent variables affect the mediator and the environmental pollution outcomes.

Anexxure (B)

Mediation Effect Of REU (DOLS)

	DEPENDENT EE		DEPENDENT EE		DEPENDENT EE	
Variable	**Coefficient**	**Prob.**	**Coefficient**	**Prob.**	**Coefficient**	**Prob.**
REU					-0.007983	0
GFN	-0.021935	0.031	0.77244	0.024	-0.038126	0.0863
EG	-1.126881	0		0.0977	-0.53051	0
NRR	0.023103	0.0201	0.104696	0.0752	0.026385	0.0009
FDI	0.011113	0.0507	-0.684934	0.0004	0.000338	0.097
URB	-0.2445	0.0413	-0.245081	0.0007	-0.066515	0.4869
IT	-0.179034	0.0305	2.79712	0	-0.093318	0

R-squared	0.909022	**Mean dependent var**	1.48067
Adjusted R-squared	0.904071	**S.D. dependent var**	0.412428
S.E. of regression	0.127739	**Sum squared resid**	25.48742
Long-run variance	0.035388		

The mediation analysis utilizing panel dynamic least squares (DOLS) reveals significant information regarding the relationships between the independent variables (GFN, EG, NRR, FDI, URB, and IT) and the dependent variable EE, as mediated by the variable REU. The coefficient for REU shows a significant negative direct relationship with EE, indicating that an increase in the utilization of renewable energy is associated with a decrease in environmental pollution and an improvement in energy efficiency. The negative direct relationship between GFN and EE is not statistically significant. The direct effects of economic expansion (EG), natural resource rent (NRR), urbanization (URB), along with international trade (IT) are statistically significant, whereas the direct effect of foreign direct investment (FDI) is not. In addition, the R-squared value of 0.909022 indicates that the model's independent variables account for approximately 90.90% of the variance in EE. These findings provide insightful information for policymakers as well as institutions seeking to promote environmentally friendly energy practices and enhance the efficiency of energy through the use of renewable energy.

Anexxure (C)

Sr. No.	Variables	Source Link
1	Environmental pollution	Indicators | Data (worldbank.org)
2	Renewable Energy Consumption	Indicators | Data (worldbank.org)
3	Green Finance	Environmental policy - Patents on environment technologies - OECD Data
4	Financial Development	Indicators | Data (worldbank.org)
5	International Trade	Indicators | Data (worldbank.org)
6	Foreign Direct Investment	Indicators | Data (worldbank.org)
7	Urbanization	Indicators | Data (worldbank.org)
8	Economic Growth	Indicators | Data (worldbank.org)
9	Trade Openness	Indicators | Data (worldbank.org)
10	Total Natural Resource	Indicators | Data (worldbank.org)
11	Labour Force	Indicators | Data (worldbank.org)
12	Gross Savings	Indicators | Data (worldbank.org)
13	Infrastructure	Indicators | Data (worldbank.org)