A STUDY ON SUSTAINABLE DEVELOPMENT, RENEWABLE ENERGY CONSUMPTION AND GREEN FINANCIAL INDICATORS HAVING MEDIATING EFFECT OF TECHNOLOGICAL INNOVATION AND NATURAL RESOURCES

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A Study on Sustainable Development, Renewable Energy Consumption and Green Financial Indicators having Mediating Effect of Technological Innovation and Natural Resources

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List of Abbreviations

CADF	Cross- sectional dependency augmented ducky fuller
CIF	Climate Investment Funds
COP	Conference of parties
EG	Economic Growth
FD	Financial Development
FDI	Foreign Direct Investment
FI	Financial Inclusion
GB	Green bonds
GCF	Green Climate Fund
GF	Green Finance
IT	International Trade
NR	Natural Resource Rent
PS	Public Spending
R&D	Research and Development
RNE	Renewable energy Consumption
SD	Sustainable Development
SDGS	Sustainable Development Goals
TI	Technological Innovation
TO	Trade Openness
UN	United Nation
UNFCCC	United Nation framework Convention on Climate Change

URB	Urbanization
WDI	World Development Indicators
WHO	World health Organization

A Study on Sustainable Development, Renewable Energy Consumption and Green Financial Indicators having Mediating Effect of Technological Innovation and Natural Resources

ABSTRACT

In the past three decades, the issue of sustainability has become the focal point of all international forums, assuming a position of utmost importance. Designing a generic societal and economic paradigm that can articulate economic viability, social inclusion, and environmental sustainability is one of the greatest challenges of the twenty-first century. The most efficient method for addressing the environmental challenges faced by countries is to place an emphasis on sustainable development. To address the substantial problems that have arisen as a consequence of environmental deterioration and global warming caused by human activity, it is necessary to adopt financial processes that are socially and ecologically responsible. One such process is green finance. Green finance projects measures can help to promote sustainable economic growth, climate change, and sustainable development. Green financing is essential because it guarantees the initiatives that seek the necessary financing to reduce the world's reliance on fossil fuels. Green financial indicators can be simultaneously made possible by specialized technological innovation and natural resource rent, thereby encouraging the adoption of sustainable energy. In this Study, we examine whether and how green financial indicators influence long-term sustainable development. In this Study, we investigate the mediating mechanisms underlying the relationship among green financial indicators sustainable development and renewable energy consumption and we contribute to the ongoing discussion surrounding this relationship. Our observational analysis is derived from data collected for 66 countries between 2004 and 2019. Initially various data diagnostic techniques were applied on the data. Fully Modified Ordinary Least Square Method and Dynamic Ordinary Least Square Method was used to investigate the long-term association among the green financial indicators, renewable energy consumption and sustainable development. According to the study, green financial indicators are essential for supporting sustainable development and reducing the output of damaging carbon emissions. Through technical innovation, the effectiveness of natural resources is used can be improved, and the detrimental impacts of economic action on the environment can be decreased. In the meantime, natural resources can help sustainable development projects. Furthermore, the study found that green funding initiatives have accelerated the adoption of renewable energy sources by encouraging increases in the proportion of renewable energy in the fuel supply. Multiple analyses of reliability corroborate the existence of this link. Green funding has been shown to have an encouraging effect on the transition to renewable energy, and our findings indicate that technological advancement and natural resource leasing serve to mitigate this effect. One key recommendation is to prioritize the implementation of green financing mechanisms in these countries. By promoting and facilitating investments in renewable energy and environmentally sustainable projects, governments can drive economic growth while simultaneously addressing environmental concerns. This includes developing policies that encourage financial institutions to support and fund green initiatives, as well as providing incentives and subsidies to attract private investments in RNE. By implementing these policies effectively, these countries can make significant strides towards sustainable development, mitigating environmental degradation, and securing a more resilient future for their citizens.

Keywords: *Green finance, Sustainable Development, Climate Change, Environmental Degradation, Renewable Energy, Technological Innovation.*

CHAPTER ONE

INTRODUCTION

1.1 Background of Study

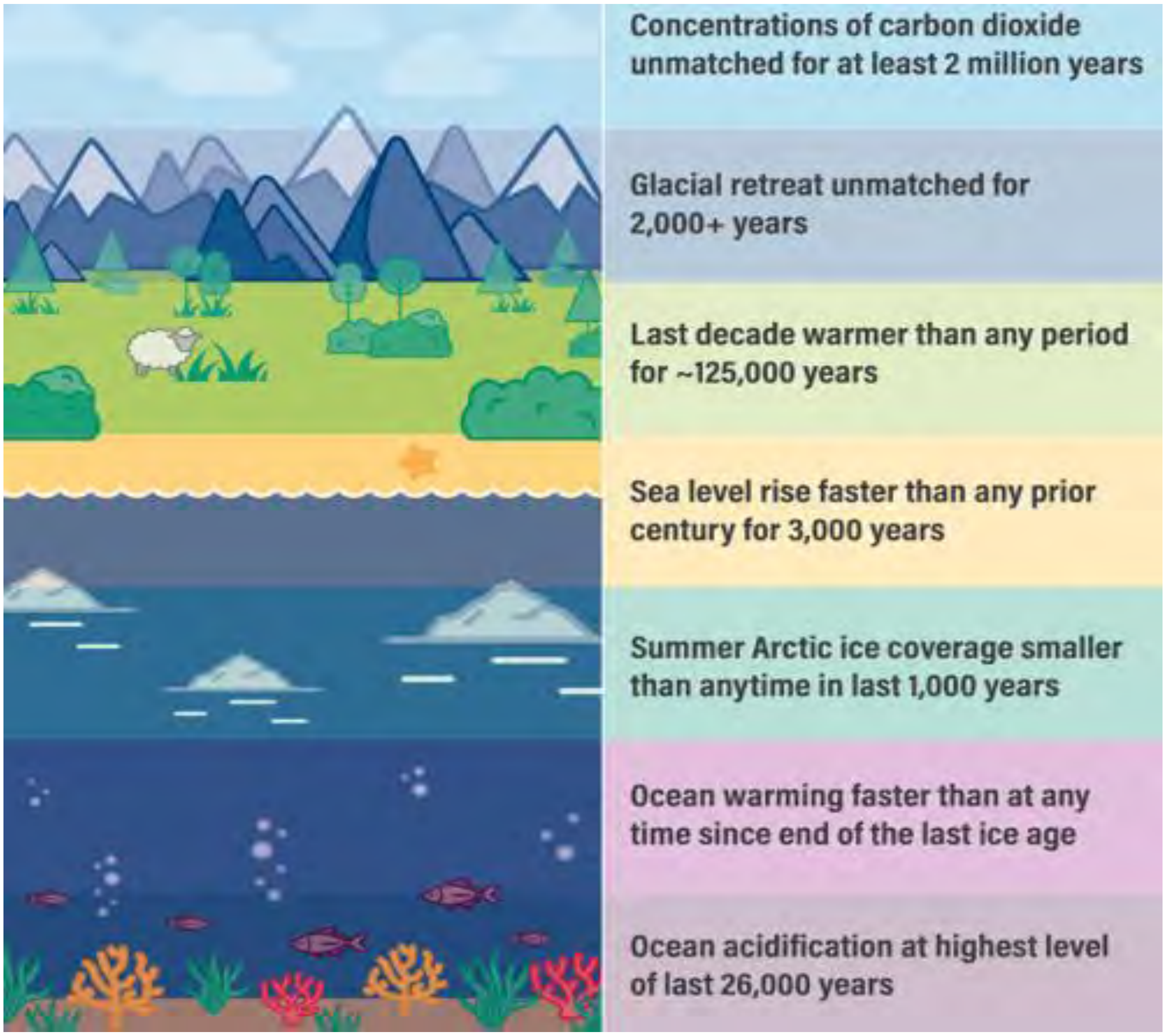
Global climate change is human beings' most significant issue in the 20^{th} century. The UN Framework on Climate Change (2022) describes the "climate system" as "the entirety of the atmosphere, hydrosphere, biosphere, and geosphere and their interactions." Numerous studies identified an effect of Climate change as the rise in the sea level, rise in temperature, extreme weather, low level of agriculture production, and environmental degradation, which are severe threats to human health as well as social stability and suitability (Cui et al., 2022; Bush, et. 2021; Hao et al., 2021). Since the industrial revolution, the consumption of fossil fuel has been massively increased due to which CO_2 emission and other greenhouse gases (GHGs) are increasing and causing serious threats to the environment. These greenhouse gases (GHGs) cause the decline of environmental quality and climate change. For instance, even though the yearly growth rate of emission of greenhouse gases has decreased from a rate of 2.1% annually between the years 2000 and 2009 to 1.3% every year among 2010 and 2019, global progress in reducing the effects of climate change remains hopelessly behind schedule. According to Boehm & Schumer's (2023) projection, global greenhouse gas emissions are expected to have reached 59 gigatons of carbon dioxide equivalents in 2019, which is around 12 percent higher than in 2010 as well as 54% higher than in 1990. The emissions of fossil fuel burning, and cement manufacturing were the primary contributors to the increase in atmospheric carbon dioxide that caused it to surpass 149% of pre-industrial levels in the year 2021. Since the lockdowns in 2020 that were caused by COVID-related events, worldwide emissions have soared (Renewable Energy Statistics, 2022).

Quantifying emissions by source type for the greenhouse gas methane, the second-greatest contributor to climate change and whose sources and sinks overlap, is challenging. Since 2007, the methane accumulation in the environment has enhanced in the significant rapid pace. Since systematic records began in 1983, the yearly rises in 2020 and 2021 (15 and 18 ppb, respectively) are the greatest since the beginning of the study. The global greenhouse gas science group is continuing to investigate the causes. The analysis reveals that biogenic sources, especially wetlands and rice paddies, have contributed the most to the resurgence of methane emissions since 2007 (Greenhouse Gas Bulletin | World Meteorological Organization, 2023). It is impossible to determine whether the significant increases in 2020 and 2021 constitute climate feedback – if the temperature rises, organic matter decomposes more quickly. If it decomposes in water (without oxygen), methane emissions result. Thus, an increase in emissions is conceivable if tropical wetland conditions become wetter and warmer. The remarkable increase could also be attributable to natural interannual variation. La Nia events, linked with increased tropic precipitation, occurred in 2020 and 2021 (Greenhouse Gas Bulletin | World Meteorological Organization, 2023). Industrialization has caused social and environmental problems like climate change to increase economic growth. Climate change adversely affects the environment and the life of the living species.

Recent research Muhammad et al. (2022), Prempeh (2023) Sadiq et al. (2022) indicates that between the years 2011 and 2020, the mean temperature of the earth's surface was 1.09 degrees Celsius higher than it had been between the years 1850 and 1900. Global warming will result in a mean temperature increase of 1.50°C over the next two decades. These adverse effects of climate change have the same global reach (Irfan et al., 2022). Since the pre-industrial era, global average warming has been limited to two degrees Celsius, the aim now recognized by most international nations. Signatories of the Paris Agreement promised to execute measures to curb temperature rise to 1.5 °C and maintain it far below two °C. A global census is undertaken every five years to calculate the necessary emission reductions. This would result in substantial, long-term declines in carbon dioxide emissions throughout the twenty-first century. However, many other effects, such as the transitory rise in sea level, acidification of the oceans, and net primary production on Earth, cannot be controlled by a global temperature target. For the first time, the World Commission on Environment and Development (WCED) defines sustainable development as progress that meets the demands of the present without compromising those of future generations. For the first time, the World Commission on Environment and Development (WCED) defines sustainable development as progress that meets the demands of the present without compromising those of future generations. Energy sustainability evaluations consider the role of energy's negative externalities. Emerging severe ecological issues and energy crises threaten society's ability to evolve sustainably. The global community has proposed goals for sustainable development (SDGs). However, these objectives are not accomplished at the expected rate.

Rising global warming has been related to a rise in the occurrence and strength of severe weather issues such as cold and warm waves, flooding, droughts, wildfires, and storms. In 2021, 9.8 percent of the World's population suffered from food insecurity (Provisional State of the Global Climate 2022.). According to the report published by the IPCC (2023), the average temperature across the globe has increased by 1.1 degree celsius (2.0 degree centigrade). In every part of the world, the climate is undergoing changes that have never been seen in the past several centuries. These changes are unprecedented. These changes include a spike in the occurrence of extreme tropical storms, as well as a rapid melting of sea ice. The sea level is also rising as a result of these changes. A synthesis of the extra evidence for global warming may be seen in figure 1.1.

Figure 1.1 Evidence of Global Warming Underway



(Source; World Resources Institute, 2023)

The likelihood of reaching potentially catastrophic tipping points in the climate system increases as global temperatures continue to rise. These points, which, once started to cross, can activate self-amplifying feedback effects that enlarge global warming, such as the freeze - drying of arctic tundra or the death of vast swaths of forest, are two examples. One of the most alarming conclusions of AR6 (IPCC, 2023) is that climate change's negative effects are now wider-reaching and more severe than was first predicted. There is a serious lack of water for at least one month each year for approximately half of the world's population, and rising temperatures are a major contributor to this problem. Already, the impact of global warming is much more pervasive and drastic than was initially anticipated when scientists first began studying the phenomenon. Some examples of these diseases include malaria, West Nile virus, and Lyme disease. Crop productivity growth in Africa has decreased by a third since 1961 as a direct result of climate change's negative impact on agriculture. is that climate change is having far-reaching and catastrophic consequences that were not anticipated.

In addition to this, since 2008, extreme weather flood events and cyclones have been responsible for the annual displacement of over 20 million people (Boehm & Schumer, 2023). There are currently between 3.3 and 3.6 billion people living in countries that are extremely susceptible to the effects of climate change. The majority of these people live in regions of the world that are concentrated in the Northern hemisphere, Latin America, Emerging Economies, South Asia, and a substantial percentage of sub-Saharan Africa. In many of these countries and regions, unrest, conventional disparity, and economic challenges (such as poor and confined access to basic services like fresh water) not just to enhance acuity to climate threats but also restrict the adaptability of local communities. This makes it more likely that local communities will be negatively impacted by climate change. Mortality rates due to typhoons, floods, and droughts were 15 times higher in countries that had a high vulnerability to climate change between the years of 2010 and 2020 compared to countries that had a very low vulnerability. The work that is being done to slow climate change runs the danger of bringing about disorienting shifts and exacerbating existing inequalities. It is possible, for instance, that the retirement of coal-fired power plants will result in the displacement of workers, cause harm to local countries, and reshape the social fabric of communities. On the other hand, if attempts to halt deforestation are ineffective, this may make poverty and lack of food security even worse. In addition, particular climate policies, such as carbon taxes, which raise the price of emissions-intensive products like petroleum and have the potential to be regressive if no efforts are made to reinvest the tax revenues in programs that benefit low-income communities, can also have this effect (IPCC — Intergovernmental Panel on Climate Change, 2023).

Globally, exceedingly dependent communities and ecosystems are presently struggling to adapt to the effects of global warming. This is a problem because of the interconnected nature of these populations and ecosystems. Some people believe these constraints are "soft," meaning that there are effective adaptation measures, but institutional, political, and social obstacles curtail their application. One example would be a lack of technical guidance or insufficient provision that doesn't even reach populations where it is required. People and ecosystems in other regions, on the other hand, have already reached or are rapidly approaching "hard" adaptation limits. This is the point at which the frequency and severity of climate effects due to global warming of 1.1 degrees Celsius have reached a tipping point beyond which current adaptation techniques can avert losses and damages. However, some places' people and ecosystems have already hit or are dangerously close to "hard" adaptive limitations. If the world warms by 1.1 degrees Celsius, climate change will have such widespread and severe consequences that no current adaptation techniques would be able to fully avert losses and damages. For instance, shoreline communities in tropical regions have witnessed the widespread demise of entire coral reef ecosystems, which once provided support for the communities' means of subsistence and ensured their safety from hunger. Other low-lying communities have also been forced to relocate to higher ground and abandon cultural sites as a result of rising sea levels. In the event that vulnerable communities are forced to contend with either soft or hard adaptation limits, the result is frequently irreversible and catastrophic.

These losses and damage are only going to get worse as the planet continues to warm up. When the world average temperature rises by more than 1.5 degrees Celsius, areas that are dependent on snowfall and glacial runoff are likely to encounter severe water shortages that cannot be adapted to. At a temperature of 2 degrees centigrade, the likelihood of simultaneous maize production failures in key growing regions will dramatically increase. In addition, communities in southern Europe will be placed in jeopardy of having their health suffer if summertime temperatures rise above 3 degrees Celsius (Boehm & Schumer, 2023).

In light of the environmental dangers of recent decades, steps must be taken to cut back on the release of carbon dioxide and the production of greenhouse gases if humanity is to have any hope of maintaining a pleasant way of life in the years to come. Among the most significant economic policy concerns of the early 21st is climate change, and many people think that improving green financing is an efficient way to reduce greenhouse gas emissions. The advancement of technology is the "double-edged sword" that is seen as both a significant cause of issues such as climate change, ecologic imbalances, and burgeoning pollution, as well as an effective solution to approach these issues and enhance sustainability. "Green innovation," which blends environmental preservation and technological progress, is what makes the link between environmental and economic construction and economic growth possible. Green innovation combines environmental protection and technological progress (Y. Sun et al., 2022). Foreign Direct Investment and public spending have improved the local natural environment by bringing in more sophisticated management techniques and ideas.

The zero-carbon goal is not likely to be reached any time soon, despite the approval of seventeen (17) goals for sustainable development (SDGs). Many countries and international initiatives are taking precautions against the economic losses resulting from climate change's exterior costs if they are not ready for severe weather, natural disasters, and other consequences (Botta, 2019). Global efforts such as the Conference of the Parties (COP) have promoted the Sustainable Development Goals (SDGs) to help nations deal with climate change. At COP26, approximately 200 countries pledged to reduce global carbon emissions by joining the Climate treaty. SDGs, which include retooling the manufacturing process to use green energy, are required for nations to make progress toward a more ecologically benign future due to the negative effects of pollution on human health, agriculture, and companies (Farzanegan & Raeisian Parvari, 2014). However, there are still obstacles to reaching net-zero pollution targets, the majority of which are linked to the creation of cutting-edge green technologies. Not only do necessary technologies lack widespread proof of concept, but they also require enormous amounts of private investment to be implemented. Countries are struggling to switch to green energy because there is not enough funding from the business sector.

However, finance is contributing to the mitigating effect of climate change. Finance is essential to understanding anthropogenies, or the effects of humans on the environment, However, not much has been done to integrate environmental issues into finance. Recent times have seen increased interest in green finance due to the general agreement for environmental protection, steps taken to combat climate change, and the achievement of SGDs. Green finance is a topic that needs more clarification, and Researchers have not yet agreed on its definition. Green finance is the term that combines the business and finance world with environment-friendly behaviors. Green Finance includes only the business community and participants from every field of life. Green can be guided by either financial incentives or the desire to rescue the world, or it can be led by a combination of the two.

In simple words, the term green finance involves the traditional market by creating a different range of financing tools that can deliver both economic profit and eco-friendly development. There are a number of names that commonly refer to green finance, including "sustainable finance," "climate finance," and "green investment." At the eleventh G-20 summit, held in Hangzhou, China in 2016, green finance reached its highest point of importance, as the topic was extensively covered in the media and debated (Akomea-Frimpong et al., 2021). Utilizing green financial instruments is one way to contribute to the creation of a greener environment. This process resulted in the development of new financial instruments by financial intermediaries and markets. Some examples of these new financial instruments include green bonds (GB), green credits for home mortgages, green credits for marketable buildings, ecologic home financing programs, and "go green" auto credits (Saeed Meo & Karim, 2022a). Green finance and other economic factors can play an essential role in the effort to address the climate and clean or renewable energy consumption issue in a manner that is consistent with the SDGs. During the past few years, one of the most efficient approaches that have emerged as a viable option is using green financing to expedite investment in green projects.

By providing a bank or government guarantee, green financing instruments can gain investors' confidence from the private sector for green initiatives. Boosting the level of profitability of these projects is one way to make them more appealing to potential investors (Khan et al., 2022). The study by Khan et al. (2022.) leads to the conclusion that green financing can assist developing nations in promoting environmental conservation activities that contribute to green economic growth and sustainable development, and this can be accomplished with the assistance of green finance. According to Irfan et al. (2022), Wang et al. (2022) and Zhou et al. (2022), Because of the rise in costs due to the spread of corona disease, the government's ability to fund environmental related investments has decreased. Utilizing green funding tools will be an efficient way to make up for this gap in capital. Sustainable finance is a growing industry that supports initiatives that are good for both economies and the ecosystem, such as those that use green energy (L. He et al., 2019a). A green finance system is necessary to address environmental issues created by a lack of funding and to support sustainable energy projects (Shahzad et al., 2022). The Climate Investment Funds (CIFs), Green Climate Fund (GCF) are just a few examples of the many climate funds that make up today's climate finance infrastructure the UNFCCC governs GCF, the AF, and the GEF (Shawoo et al., 2022).

The provision of financial resources that are interconnected to ecological sustainability is one of the reasons why financial development is essential (Aljadani, 2022). Lending money to private investors through commercial banks and other financial institutions can help the economy to grow over the long term. Because the provision of financial services is essential to the expansion of sustainable development, the support of renewable energy initiatives can be aided by a respectable financial institution (M. S. Islam, 2022). The reduction in energy consumption that results from increased wealth has a significant impact, both positively and negatively, on the quality of institutions. Additionally, a financially secure system makes it easier to gain access to finance, which improves people's standards of living and fosters economic expansion. The existence of a developed monetary system and the availability of financial resources contribute to the development of contemporary and practical technologies that are less harmful to the environment and more environmentally sustainable, thereby reducing the number of problems associated with pollution (J. Li, Jiang, et al., 2022).

In addition, the promotion of corporate linkages, the stimulation of technical divisions to pass on green technology, and the facilitation of research and development in the host nation are all results of financial development and the liberalization of capital markets. The need to combat climate change requires financial development for a number of reasons, which have been uncovered through theoretical research. For instance, financial development makes it easier for investors from the private and public sectors to take part in projects involving renewable energy; it also lowers the risk of diversification and the costs incurred by intermediaries (M. A. Nasir et al., 2019). A highly developed financial sector that is attractive to FDI will lead to R&D initiatives that will increase revenues and decrease negative effects on the environment. Significant inflows of foreign direct investment encourage the deployment of innovative solutions, which in turn improves the environment's capacity for withstanding the test of time both locally and globally.

When nations get FDI, they see a rise in their quality of life because of the money that is injected into their economy. Foreign direct investment (FDI) is seen by some experts and politicians as having the potential to greatly aid in a country's development efforts (S. Huang & Liu, 2021). Foreign investment in highly industrialized nations has been primarily driven by trade liberalization. According to research presented by (L. Zhou et al., 2022), it has become more important as a generator of new income in these countries. It is expected that traditional agriculture would need to rise by 35% to maintain the world's projected 9 billion inhabitants by the year 2040. This would increase agricultural greenhouse gas emissions, which account for a minor portion of the total (Jin et al., 2022).its importance as a generator of fresh money in these countries has grown. A 35 percent increase in conventional agriculture is anticipated to be necessary to feed the world's predicted 9 billion inhabitants by 2040.

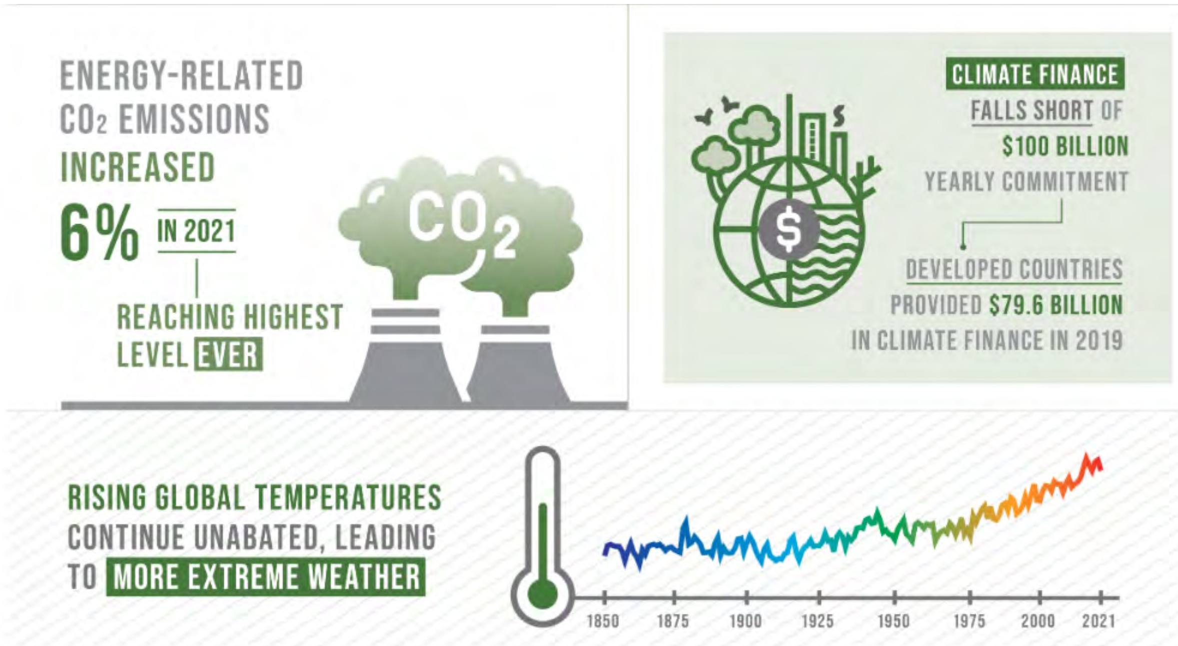
Similarly, natural resources are crucial to the economics of developing countries. These nations' economies are based on exploiting their abundant natural resources (Mohsin et al., 2021). Natural resources are frequently cited as the driving force behind modern manufacturing, as they serve as the material foundation upon which all forms of existence must ultimately depend. Because human existence cannot be sustained without essential natural resources, these resources must be preserved (Xia et al., 2020).

According to Wiedmann et al. (2018.), because of globalization, countries can experience GDP growth, but this growth comes at the expense of a shift in the enormity and spatial distribution of negative environmental and social effects. When it comes to the environment, international trade plays a strategic role in strategically separating environmental pollution caused by consumption from environmental degradation caused by the production of consumer products. This separation provides a mechanism for transferring emissions of pollution related to consumption, particularly carbon emissions, to distant places where goods are produced. There is a close connection between this phenomenon and the "pollution haven hypothesis" (Levinson & Taylor, 2008). Internationally, commerce around the World has had a profound effect on the social development of all nations, particularly in terms of employment. Like the exchange of emissions of pollutants, developed nations typically outsource unskilled labor to developing nations, resulting in an exchange of employment opportunities. in terms of creating new wealth for these countries, its importance has grown. In order to feed the expected 9 billion people in the world by 2040, traditional agriculture would need to rise by around 35% (Arto et al., 2014). thereby growing in importance as a generator of fresh income in these countries. Assuming a global population of 9 billion in 2040, conventional agriculture would need to grow by around 35% to meet food demands.

Natural resources may be a significant economic development driver. A substantial amount of the World's natural assets must be utilized to advance society and the economy. Similarly, resource bounties have been emphasized if using natural resources increases economic development. The resource curse, on the other hand, occurs when population growth and available resources coincide (Shah et al., 2019). Moreover, its role in material reproduction provides material and economic support for ecological development and sustainable growth, even though the more significant the ecological, the greater the material and economic support (Petrović-Ranđelović et al., 2019). Therefore, academicians concur that NRR are essential to a nation's economic and social development. Despite this, several studies have investigated the relationship between enhancements in financial development and natural resources and financial growth. However, none of the research investigated the connection between the availability of natural resources and openness in financial markets as a means of fostering economic expansion.

There is an urgent need to implement GF as an organizational driver to decrease environmental outwardness since overuse and mismanagement of reserves have led to severe environmental deprivation around the globe. Because its fundamental goal is the trade-off between expanding in competition with the green economy, suitable use of GF can lower negative environmental footpaths and enhance environmental superiority. We must launch green schemes using green finance bonds (GB), green banks, other new financial tools, and new policies and expand financing of investments that benefit the environment, referred to as "green finance," to achieve the SDGs. Green finance is related to sustainable development goal no. 13, which aims to take urgent action against climate change and its impact. According to the SDG no. 13 stats, CO_2 emission increase by 6% in 2021, the highest ever, due to which the global temperature rises unabatedly and more extreme weather. The other aspect of this rise in CO_2 emission may be the stat shows that World has fallen short of 100 billion dollars of the target of sustainable development goal no. 13, as shown in Figure 1.2

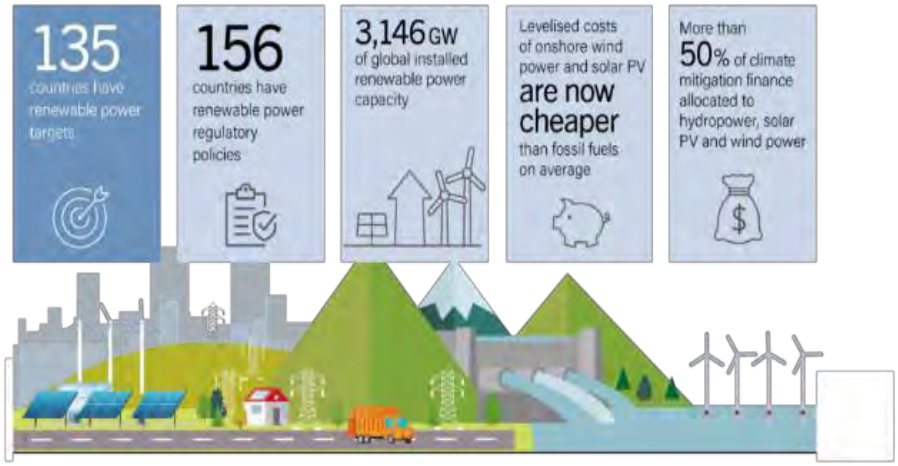
Figure 1.2 Window to Avoid Climate Change



(Source; UN Sustainable development report, 2022)

The above figure suggests that green finance can decrease carbon emissions. Energy consumption can be a fundamental cause of increased carbon emissions and Greenhouse gas emissions. Energy consumption from traditional sources is the big reason for all Greenhouse gas emissions. Additionally, it has been found that using conventional NREC sources is cheaper than using green energy because the former is cheaper and more cost-effective. Increasing the usage of non-renewable energy may increase greenhouse gas levels at the same time. Moving from NREC sources to green energy can be promoted by green finance because clean energy is more expensive. United Nations SGDs are suggesting the World move on clean energy sources. Renewable Energy Global Stats 2022 Report by REN21 issues a severe threat to world heads through a prism of facts about renewable energy. Despite the surge in clean energy production, fossil fuels are still used to generate electricity. The energy transformation is slowing in the interim. The Report's conclusions should be heard by world leaders, especially those in Asia, in light of the escalating climate issue.

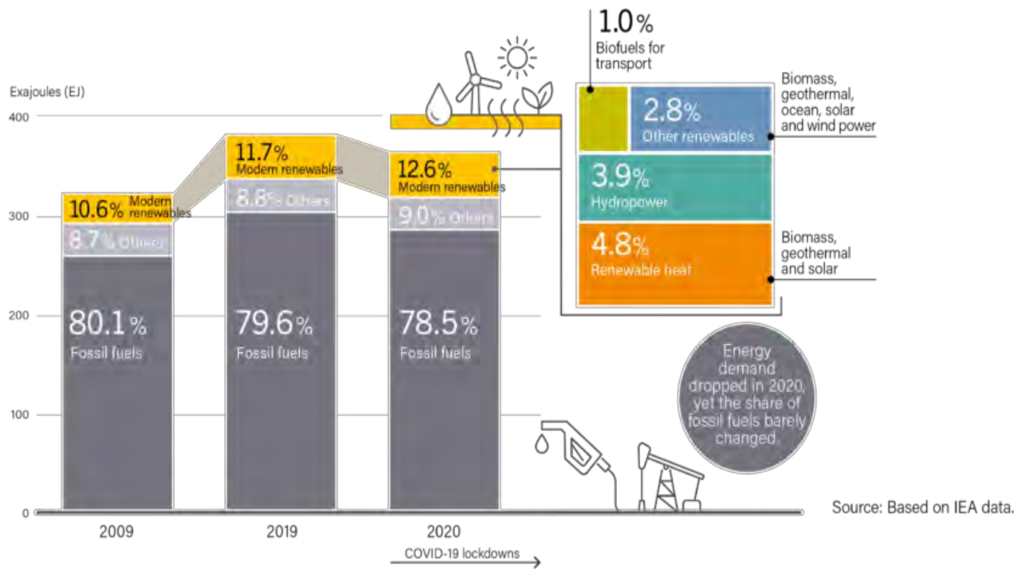
Figure 1.3 Renewables in Power



(Source; Renewables global status report, 2022)

Record levels of renewable power capacity addition were achieved. The power industry grew the most, with a record 315 Gigawatts of renewable energy power capability added. This is an increase of 17% from 2020. Wind and solar photovoltaic energy produced 90% of all newly generated renewable electricity. In 2021, 102 GW of wind energy and around 175 GW of solar PV went online. For the first time, the percentage of solar and wind energy generation in the global electricity combination exceeded 10%, as shown in Figure 1.3.

Figure 1.4 Share of Modern Renewable Energy.



(Source; Renewable Energy Statistics 2022)

The figure1.4 shows that the renewable energy consumption is increasing from the last decades but it not increasing at the speed by which it ought to be. Figure 1.4 reveals that the consumption of energy reduce in the 2020 due to the covid 19 lockdown but the percentage of fossil fuel are not deceasing effectively, that means that worlds is not accomplishing the goals that are set by the UN to combat the climate change. The Report warns that the era of inexpensive fossil fuels is over the most significant increases in energy prices since this caused the 1973 oil crisis. Many developing countries were thus left unable to cover the expenses. Gas prices in Europe and Asia increased to 10 times what they were in 2020 by the end of 2021 (Renewable Energy Statistics 2022.). The effect is that renewable energy sources are in short supply, and fossil fuels are no longer affordable. With high electricity prices and unstable supplies, this is the ideal process for an energy issue. They require a sound policy about renewable energy. To lower greenhouse gas emissions, more renewable energy sources must be used. However, renewable energy projects have difficulty getting funded because investors initially see them as high-risk, low-return investments (Noh, 2019). However, due to advances in environmentally friendly technologies and the reduced funding rate provided by green financing, the costs of renewable energy projects have recently fallen considerably (Sherman et al., 2020). If the cost of funds were decreased, the shift away from natural resources and toward renewable energies could be accelerated (Hafner et al., 2020). Financing from the private sector is the sole option available for making the switch from fossil fuels to renewable energy sources.

Financial means and financial innovation, according to Pathania & Bose (2014), have been the main factors behind every significant energy shift in history, including the shift to more environmentally friendly forms of energy. They also emphasize significance of technological advancements but the importance of financial triumphs in starting the energy transition. However, many nations find it difficult to move funds for green energy expenditures and technological advancements, posing a significant barrier to climate change prevention. Renewable energy can only be broadly embraced with business or government funding and innovative instruments. Elie et al. (2021) demonstrate the importance of keeping renewable energy sources on board, despite the high original expenditure, to cope with energy market volatility. As a consequence of this, increasing the capacity for the creation of renewable energy can be viewed as absolutely necessary in order to achieve the goal of environmental protection from the impacts of climate change. Therefore, in regard, it is completely necessary to ascertain the elements that could still foster the adoption of renewable energy sources and reduce overall reliance on fossil fuels in order to achieve the climate science objectives of SDG-13 (Abolhosseini & Heshmati, 2014). It is a common belief that insufficient funding is indeed the primary obstacle standing in the way of the transition to more environmentally friendly global energy systems. Investments in projects to develop renewable energy sources are discouraged as a result of the significant high capital costs involved in designing different types of equipment for providing energy from renewable sources. This results in an increased reliance on fossil fuels and a decrease in the rate at which renewable energy is utilized. When considering the problem of reducing the effects of climate change, it is reasonable to assume that increasing investments in research and development for the production of renewable energy will stimulate improvements in the overall quality of the environment around the world. In addition, the significance of domestic revenue mobilization for the advancement of renewable energy, particularly for mitigating factors that cause climate change, has been noted in a number of studies. This is particularly the case for mitigating climate change-causing factors (Taghizadeh-Hesary & Yoshino, 2020).

The ultimate goal of Sustainable Development Goal (SDG) 7 is to considerably increase the quantity of renewable energy sources in the global energy mix, which is directly tied to some of the fundamental climate change-related aims of SDG-13. Integrating national economic growth plans with policies relating to the development of renewable sources of energy is one way to achieve SDG-13's core aim of "integrating climate change measures into national policies, strategies, and planning. “The ultimate goal of Sustainable Development Goal (SDG) 7 is to considerably increase the quantity of renewable energy sources in the global energy mix, which is directly tied to some of the fundamental climate change-related aims of SDG-13. Integrating national economic growth plans with policies relating to the development of renewable sources of energy is one way to achieve SDG-13's core aim of "integrating climate change measures into national policies, strategies, and planning." In this context, achieving the targets of Sustainable Development Goal 7 to "promote investment in the development of energy infrastructure and clean energy technology" and "expand infrastructure and upgrade technology for supplying modern and environmentally sustainable (clean and renewable) energy services" is crucial to the success of this initiative. Therefore, it is expected that increasing investments for the investment in infrastructure related to sustainable power will serve as a solid action plan for building resilience against a variety of repercussions of climate change.

At least 170 countries have incorporated adaptation into their climate policies, but many nations have yet to transition from strategies to implementation. The majority of the measures that are being taken to build resilience are still on a small scale, are being taken in reaction to current events, and are being taken incrementally. Because there are not enough financial resources. There is indeed a disparity between the degree of adaptability that is currently taking place and the level that is required. The IPCC (2023) estimates that developing nations will need $127 us$ every year by 2030 and $295 billion each year through 2050 in order to adapt to the effects of climate change. From 2017 to 2018, funding for adaptation totaled only $23 billion to $46 billion, which is equivalent to between 4 percent and 8 percent of total climate finance. The failure to meet the target for climate finance will have far-reaching consequences. According to the IPCC (2023.), there is a greater than fifty percent chance that the mean temperature of the earth will increase by at least 1.5 degrees Celsius between the years 2021 and 2040, regardless of the scenario that is investigated. If we continue on our current path of high emissions, the world may reach that point even earlier, somewhere between the years 2018 and 2037. In such a carbon-intensive scenario, the mean temperature of the earth could rise by anywhere from 3.3 to 5.7 degrees Celsius by the year 2100. When temperatures on Earth last rose by more than 2.5 degrees Celsius (4.5 degrees Fahrenheit) above their pre-industrial levels, it was more than 3 million years ago.

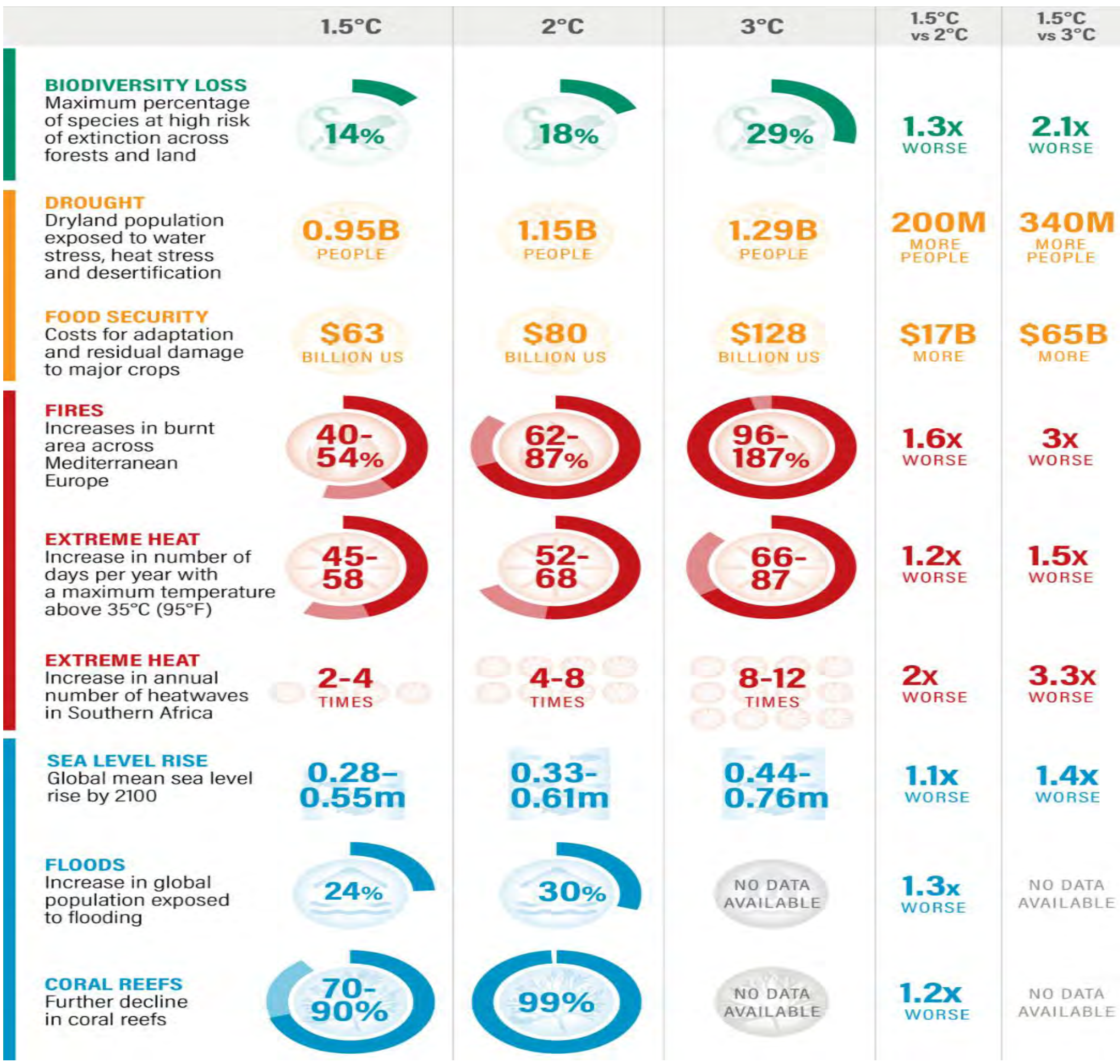
According to the World Bank, by 2050, 216 million people may move within their respective countries because of climate change. The average percentage of climate finance in the

World Bank Group's overall obligations has increased to 35% under its Climate Change Action Plan, which covers the fiscal years 2021–2025. The strategy prioritizes those industries that produce 90% of the World's greenhouse gases and need to alter to combat climate change. As indicated by the (WHO), between 2030-2050, climate change is supposed to trigger an additional 250 000 casualties per year; malnutrition, malaria, diarrhea, and heat stress are the leading causes of death., and between USD 2-4 billion/year in direct health damage expenses by 2030 (i.e., omitting costs in industries that determine health, such as agricultural and sanitation and water supply) (Climate Change and Health, 2022). Future strategies for mitigating climate change may substantially affect the rate and amount of the rise in global average temperature brought on by long-lived greenhouse gases, which negatively affect human health. United Nations and other countries and institutions focus on implementing the SDGs but lack the pace to combat environmental issues. Still, CO_2 and GHG emissions are increasing (Climate Change and Health, 2022).

The severity of these shifts will be amplified as global warming continues. For example, a global temperature of 0.5 degrees Centigrade (0.9 degrees fahrenheit) will result in measurable traits increased frequency and intensity and intensity of temperature extreme ends, torrential rain events, and regional extreme weather events. These changes will take place over the course of the next century. Also, heatwaves will likely occur 4.1 times more frequently with an increase in temperature of 1.5 degrees Centigrade, 5.6 times with an increase in temperature of 2 degrees Centigrade, and 9.4 times with an increase in temperature of 4 degrees Centigrade — and the intensity of these heatwaves will increase by 1.9 degrees Centigrade, 2.6 degrees Centigrade, and 5.1 degrees Centigrade, respectively (Boehm & Schumer, 2023). These dangers will be magnified by even a fraction of the degree of warming, and even limiting the rise in global temperature to

1.5 degrees Celsius won't be enough to protect everyone. For example, 950 million people in the world's drylands will endure water stress, heat stress, and desertification if global warming continues at this rate. Furthermore, the percentage of the world's population that is exposed to inundation will increase by 24 percent, as shown in Fig. 1.5 these negative effects will be caused by climate change.

Figure 1.5 Comparison of rise in the temperature and its impact on the World

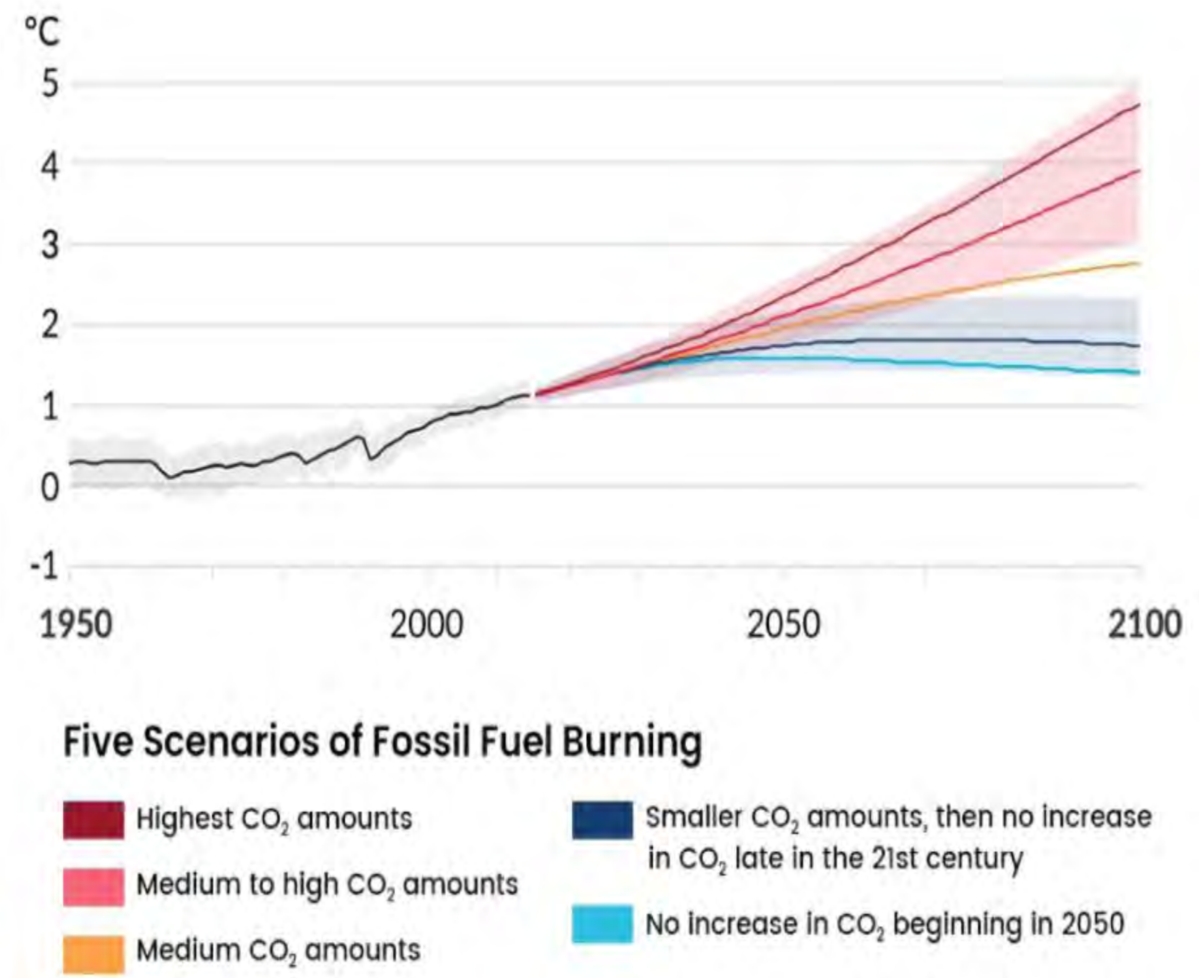


(Source World Resources Institute | Making Big Ideas Happen, 2023)

In a similar manner, exceeding 1.5 degrees Centigrade, even momentarily, will result in much more severe and frequently irreversible consequences. These consequences include the extermination of native wildlife, the finished flash floods of saline marshlands, and the human casualties due to increased heat stress. Maintaining a global temperature increase that is close to or below 0.5 °C will be essential for ensuring a secure and livable future and limiting the intensity and period of overshooting to 1.5c. Celsius will also be essential in this regard. Even if the current temperature limit is exceeded before the turn of the century, there is still an urgent need to significantly cut emissions of GHGs in order to prevent further warming and the consequences that come along with it. Climate models project that the average global temperature will rise by an additional 4°C during the 21st century if the levels of greenhouse gases continue to rise at the same rate at which they are rising now. Models predict that if greenhouse gas emissions are not rapidly reduced, it may be impossible to keep global average temperatures within a range of 1.5 to 2°C above pre-industrial levels. This range corresponds to a range of 2.7 to 3.6 degrees Fahrenheit (World Resources Institute | Making Big Ideas Happen, 2023).

The choices that are made now will determine the degree to which the climate will shift at the turn of the century. The best-case scenario calls for us to cut CO_2 levels enough so that they stop rising after 2050; this will result in an increase of one to one and a half degrees Celsius in the average global temperature (blue line on the graph). If we do not take action to lower CO_2 emissions and their levels continue to climb, we will create the most catastrophic possible climate (Center for Science Education, 2023.). Increases in temperatures will lead to alterations to other aspects of the climate, including precipitation, snowfall, and cloud cover. They also alter the ocean, life, ice, and every other component of the Earth's system. High temperatures will cause a higher rate of vaporization. More atmospheric water vapor will increase precipitation. Each degree of warming can result in a 7% increase in global average precipitation, which translates to a future with much more rain and snow and a higher risk of inundation in some regions. With a 2°C increase in temperature, torrential rainfall is anticipated to become 1.7 times more frequent and 14% more intense. However, the distribution of variations in precipitation will not be uniform. Some areas will receive more, while others will receive less (Predictions of Future Global Climate | Center for Science Education, 2023.).

Figure 1.6 Projected Raise in Temperature



(Source; Center for Science Education, 2023.)

Developing economies must produce local solutions in finance, economic growth, and financial development to minimize this global warming. Finance is essential to understanding anthropogenies or the effects of humans on the environment. Sustainable Development Goal (SDG) 7 aims to considerably increase the quantity of renewable energy sources in the global energy mix, and it is possible to draw a line from some of SDG-13's fundamental climate change-related objectives to this overarching goal. To achieve SDG-13, which aims to "integrate climate change measures into national policies, plans, and planning," for example, national economic growth policies should be merged with policies concerning the development of renewable sources of energy.

1.2 Problem Statement

In recent times, the World has been facing climate challenges. Climate change poses significant and unprecedented challenges to the globe, affecting various factors, including drought, global warming, polar ice melting, ozone layer degradation, deforestation, the introduction of new illnesses, and changes in species. The 2015 Paris Agreement represented a critical worldwide commitment to address climate change by decreasing pollution and limiting global warming to 1.5°C above pre-industrial levels (Shang et al., 2023a). However, with the current global temperature rise of 1.1°C, unprecedented climate system changes are occurring around the World, including rising sea levels, extreme weather events, and diminishing sea ice (Boehm & Schumer, 2023). One alarming finding from the AR6 report IPCC (2023) is that there is a serious lack of water for at least one months per year for about half of the world's population, and since 2008, this problem has been becoming worse., millions of people have been displaced yearly due to extreme floods and storms. Moreover, 3.3 and 3.6 billion people live in highly vulnerable regions to climate change's effects IPCC (2023). Existing climate policies in roughly 170 countries emphasize adaptation. However, the switch from planning to execution remained limited, perpetuating the gap between current resilience levels and requirements. The continued existence of this adaptation disparity can be primarily attributed to the limited availability of funds. The IPCC (2023) prioritizes the essential function of rising finance, transfer of technology, and global collaboration in accelerating the necessary climate action. According to the IPCC (2023), the current distribution of climate finance falls far short of the estimated requirements, which have been estimated to be three to six times greater. To effectively adapt to climate change, developing nations require 117 billion dollars annually by 2030 and $295 billion annually by 2050 (World Resources Institute, 2023). In this context, this study seeks to investigate the correlation between green finance and climate change, particularly addressing inequalities in adaptation efforts and financing requirements. The research will investigate how green finance mechanisms can close the adaptation gap, facilitate technology transmission, and promote international cooperation in the fight against climate change. In addition, this study will assess the current state of climate finance, identify obstacles to its effective dissemination, and propose strategies for mobilizing sufficient financial resources to support climate change adaptation initiatives.

1.3 Research Gap

According to the literature described above, there is still certain research even though academics have commenced to concentrate on the green finance, renewable energy consumption. and emissions nexus. There are different measures of green finance which are used in the literature. Many researchers use green bond index, green investment, green credit, and green policies to measure green finance (Rasoulinezhad & Taghizadeh-Hesary, 2022; Saeed Meo & Karim, 2022). But few researchers use Environmental protection products (C. Li et al., 2022.). So, this study is going to explore how various green financial indicators are helpful in promoting sustainable development. Secondly, in literature, many studies (Awosusi, Adebayo, Kirikkaleli, & Altuntaş, 2022; Awosusi, Adebayo, Kirikkaleli, Altuntaş, et al., 2022; Jinqiao et al., 2022.) took technical innovation and natural resources as independent or control variables, but never as mediators, in the relationship between green finance and sustainable development. This study is going to explore that Does Technological innovation & Natural resources help green financial indicators in promoting sustainable development?

1.4 Research Questions

This study investigates the complex association among the independent variables (green finance, financial inclusion, financial development, FDI, international trade, and public spending) and the mediating variables (technological innovation and natural resources rent). The dependent variables in this study are sustainable development and renewable energy. This research attempts to answer these questions to better understand the situation to better understand the situation of the mechanisms and interrelationships that promote sustainable development and the use of renewable energy. The research questions provide a framework for understanding the main determinants and potential policy consequences of promoting sustainable development and transitioning to renewable energy sources.

Q1: What role do green financial indicators play in promoting sustainable development and renewable energy sources?

Q2: How can technological innovation function as a mediating factor between green financial indicators and Sustainable development and the deployment of renewable energy sources?

Q3: How important is the natural resources rent as a mediating variable between the green financial Indicators and Sustainable development and the implementation of renewable energy?

1.5 Research Objective

This study aims to explore the contribution of green financial indicators in promoting Clean Energy and Environmental Sustainability. The primary objective of this research dissertation is to examine the relationship between GF and climate change, with a particular emphasis on determining the role of TI and NRR as mediators. As the UN report reveals that CO_2 emission is increasing every year and the World is failing to achieve green investment, this study aims to explore this issue and give policy recommendations to improve green finance investment to achieve the targets set by the UN. Secondly, it is seen that renewable energy project is expensive, and Govt and private sector are not investing in renewable energy project as they should be. So, this study will explore how green financial indicators can help promote renewable energy projects. The objective is listed below:

- First, explore how green financial indicators can help promote environmental sustainability and Renewable energy Consumption.
- Second, investigate how mediation of technological innovation and natural resources can help promote Environmental sustainability and renewable energy consumption.
- Examine the effect of financial development on the connection between green finance and climate change mitigation and how establishment financial systems and organizations enhances the execution of GF strategies and leads to reduced emissions and the adoption of renewable energy.
- To provide policy recommendations to Government and Institutions achieving green finance targets and sustainable development goals set by the UN.

By achieving these research objectives, this study seeks to deepen our comprehension of the intricate relationship between green finance, climate change, and the mediating variables of TI and NRR. The findings will aid in creating evidence-based policies and plans that foster sustainable development, emission reduction, and adoption of renewable energy by policymakers, financial institutions, and stakeholders.

1.6 Rationale of the Study

Climate change poses a substantial hazard to the global environment, economy, and society, necessitating immediate action to mitigate its adverse effects. Green finance, which focuses on financing environmentally sustainable initiatives and endeavors, has emerged as an indispensable instrument for addressing climate change issues. Understanding the complex relationship between green finance and climate change, as well as the mediating effects of technological innovation (TI) and natural resource rent, is crucial for devising innovative approaches to combat climate change and promote sustainable development.

- Even though numerous studies (Abbas et al., 2023; Hou & Fang, 2023; Policy & 2023, 2020) have investigated the relationship between green finance and climate change, there is a significant knowledge gap regarding the specific mechanisms by which various green financial indicators influence greenhouse gas (GHG) emissions and renewable energy consumption. In addition to that, not much focus has been placed on the mediating effects of TI and NRR in this relationship.
- This study's findings will have significant policy implications for governments in the first-place financial institutions and stakeholders engaged in climate change mitigation and sustainable development.

- This research is in keeping with the Sustainable Development Goals (SDGs) that have been stated by the United Nations, notably SDG 13. (Climate Action). This study contributes to the realization of global climate goals by focusing on the connection that exists between sustainable finance and climatic shifts. It makes it easier to transition to an economy with lower carbon emissions.

1.7 Significant of the Study

The increasing severity of climate change impacts calls for immediate action to meet the problems of increasing GHG emissions and the necessity for the widespread adoption of renewable energy sources. As this investigates the link between green finance and climate change, this dissertation is highly noteworthy because it sheds light on financial systems' role in reducing the effects of climate change and fostering sustainable development.

- This research is crucial to solving the urgent problem of our changing climate. This study aims to provide light on the effectiveness of financial mechanisms in lowering GHG emissions and increasing renewable energy use by examining the connection between green financial indicators and climate change. The results can help guide policy and action toward climate change mitigation and a low-carbon economy.
- Understanding how green financial indicators can effectively reduce GHG emissions and encourage renewable energy consumption can assist policymakers and stakeholders in implementing targeted strategies to combat climate change and working toward achieving the goals outlined in international climate agreements.
- Given the urgency of addressing climate change, this study contributes substantially to promoting sustainable financial practices. This study highlights the significance of linking financial flows with environmental goals by revealing the connection between green

finance and climate change. The results enable financial organizations as well as investors to give preference to sustainable practices.

This research study contributes to our theoretical and empirical understanding of the relationship between green financing and climate change. The study provides an understanding of the complex dynamics at play by combining a variety of variables and exploring the mediating impact of TI and NRR. The study's conclusions have practical consequences for policy development, sustainable financial practices, and achieving global climate and sustainability goals.

- This research dissertation contributes significantly to the theory by investigating the relationship between GF and climate change. The study expands the existing theoretical framework and provides a more comprehensive understanding of the factors influencing greenhouse gas (GHG) emissions and renewable energy consumption by incorporating variables such as green finance, financial inclusion, financial development, international trade, foreign direct investment (FDI), public spending, TI and NRR.
- Secondly, incorporating mediating variables, such as TI and NRR, improves comprehension of the underlying dynamics in the green finance-climate change nexus. The research investigates the mediating effect of technological innovation and natural resource rent in the link between green finance, GHG emissions, and renewable energy consumption. This research contributes to a more sophisticated understanding of the complex mechanisms of mitigating climate change through green finance.

1.8 Initial Findings

This study uses STATA 17.0 software for the data analysis and runs basic descriptive, correlation, and regression analysis. The table given below represents the initial finding of the study.

1.8.1 Descriptive Statistic

Descriptive statistics show the result range mean and standard deviation of the data of variables.

Table 1.1 Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Greenhouse gases	1056	7.5390	16.3575	11.494022	1.6674806
Renewable Energy use	1056	4.6052	4.5143	2.249937	1.6926241
Green finance	1056	0.1744	4.6052	2.509248	0.6635100
Financial inclusion	1056	2.4079	5.2711	3.616679	1.2370247
FI2	1056	1.7720	4.6477	2.830707	0.9723592
Financial development	1056	1.6811	5.7189	4.003281	0.8376762
International Trade	1056	1.2067	5.4337	3.671778	0.5969782
IT2	1056	1.7522	5.3391	3.741576	0.5077797
FDI	1056	6.3935	6.1072	1.161041	1.3460634
Public Spending	1056	0.1621	2.2523	1.437870	0.3539967
PB2	1056	4.1414	1.6370	0.394421	1.1589500
Natural resources	1056	9.1280	4.1995	0.153592	2.4803430
Technological Innovation	1056	3.2838	4.4275	3.482172	0.9948505

The above statistic displays the range mean and standard deviation of the data of the variables. The data of greenhouse has mean 11.49, range 7.53 and standard deviation 1.66674. The data of renewable energy use shows the range of4.6056, mean 2.249 and standard deviation 1.6926. The data of green finance shows the range of 0.1779, meaning 2.5092 and standard deviation 0.6635. The data of financial inclusion shows the range of 2.490, mean 3.6166 and standard deviation 1.2370. The data of financial development shows the range of 1.6811, mean 4.00 and standard deviation 0.8376. The data of international trade shows the range of 1.2270, mean 3.671 and standard deviation 0.5969. The data of FDI shows the range of 6.39, mean 1.161 and standard deviation 1.3460. The data of public spending shows the range of 0.1621, meaning 1.4378 and standard deviation 0.3539. Standard deviation shows how much data is dispersed from its meaning. The data of natural resources shows range9.12, mean 0.15, and standard deviation 2.48. The data of natural resources shows range 3.28, mean 3.48, and standard deviation 0.99.

1.8.2 Correlation Analysis

These correlation coefficients illustrate the relationships between variables. Each row and column in the table represents a different variable, and the values displayed in the cells indicate the intensity and direction of the correlation between variables. The table 1.6.2 reveals the results of the correlation. According to the results, the renewable energy is significantly negatively correlated with the greenhouse gases. Which shows that if greenhouse gases increase its mean renewable energy use decreases and vice versa. This correlation is at -.261. The green finance is significantly negatively correlated with the greenhouse gases renewable energy use. Which shows that if green finance increases its mean renewable energy use & greenhouse gases decreases and vice versa. This correlation is at -.107 & -.135.

Table 1.6.2 Correlation Analysis

	GHGs	REC	GF	FI	FD	IT	FDI	PB	NR	TI
GHGs	1									
RNE	-.261**	1								
GF	-.107**	-.135**	1							
FI	0.042	-.092**	-.144**	1						
FDI	0.038	.105**	-.244**	.655**	1					
IT	-.252**	-.299**	-.123**	.407**	.316**	1				
FDI	-.382**	-.082*	-0.035	.091**	.116**	.464**	1			
PS	-.100**	-.153**	-0.029	.370**	.324**	.333**	.124**	1		
NR	.268**	-.299**	.281**	-.308**	-.409**	-.176**	-.177**	-0.036	1	
TI	.089**	0.025	-.160**	.585**	.505**	.359**	.115**	.356**	-.308**	1

**. Correlation is significant at the 0.01 level.

The Financial Inclusion is significantly negatively associated with the renewable energy and green finance and positively correlated with greenhouse gases. This correlation is at -.092, -.144 and 0.042. Financial development is significantly positively correlated with the greenhouse gases renewable energy use and financial inclusion at 0.038, .105 and .655 respectively and negatively correlated with the green finance at -.244. international trade is significantly negatively correlated with the greenhouse gasses renewable energy use and green finance at -.252, -.299 and -.123 respectively and significantly positively correlated with the FI and FD at .407 and .316

respectively. FDI is significantly negatively correlated with the greenhouse gasses renewable energy use and green finance at -.382, -.082 and -.035 respectively and significantly positively correlated with the financial inclusion, financial development and international trade at .091,.116 and .464 respectively. Public spending is negatively correlated with greenhouse gases green finance and renewable energy use at .100, .153, .029 and significantly positively correlated with the Financial Inclusion, Financial development, international trade and FDI at .370, .324, .333 and .124 respectively. The data of natural resources significantly positively correlated with greenhouse gases and green finance .268, .281. and significantly negatively correlated with the renewable energy, FI, FD, FDI, IT, PB at -.299, -.308, -.309, -.176, -.177, -.036 respectively.

1.8.3 Regression Analysis

The results of Model 1's regression analysis reveal the relationship between the Greenhouse gas Emissions and multiple independent variables. Here is a description of the outcomes

Table 1.6.3 Regression model 1

	Unstandardized		Standardized		
	B	Std. Error	Beta	t	Sig.
(Constant)	12.742	0.414		30.750	0.000
Green finance	-0.499	0.072	-0.195	-6.947	0.000
Financial inclusion	0.041	0.052	0.032	0.797	0.426
Financial development	0.365	0.075	0.182	4.883	0.000
International Trade	-0.546	0.097	-0.192	-5.658	0.000
FDI	-0.275	0.038	-0.220	-7.182	0.000
Public Spending	-0.593	0.144	-0.129	-4.107	0.000
Natural resources	0.264	0.021	0.393	12.652	0.000
Technological Innovation	0.477	0.063	0.269	7.524	0.000

*Dependent Greenhouse emissions

The above table displays the result of the regression. This table displays the results for the dependent variable greenhouse gases and independent variables and mediating. The results show that green finance, FDI, and public spending significantly negatively impact greenhouse emission, which means these reduce greenhouse emission. In contrast, financial inclusion, financial development, and international trade positively impact greenhouse emission. While mediation variables also have a significant positive effect on greenhouse emissions, which indicates that these variables contribute to greenhouse emissions.

1.8.4 Regression Analysis

Similarly, table 1.6.4 shows the results of Model 2's regression analysis that reveal the relationship between Renewable Energy Consumption and multiple independent variables. Here is a description of the outcomes

Table 1.6.4 Regression model 2

	Unstandardized		Standardized		
	B	Std. Error	Beta	T	Sig.
(Constant)	6.305	0.441		14.283	0.000
Green finance	-0.140	0.076	-0.054	-1.839	0.066
Financial inclusion	-0.276	0.054	-0.211	-5.064	0.000
Financial development	0.289	0.079	0.143	3.668	0.000
International Trade	-1.168	0.104	-0.406	-11.208	0.000
FDI	0.145	0.041	0.113	3.497	0.000
Public Spending	-0.383	0.152	-0.083	-2.519	0.012
Natural resources	-0.185	0.022	-0.270	-8.367	0.000
Technological Innovation	0.221	0.068	0.123	3.272	0.001

*Dependent variable Renewable energy use.

Above table displays the result of the regression. This table reveal the results for the dependent variable Renewable energy use and independent variables and mediating. The results shows that green finance has negative impact on renewable energy consumption and is significant at 90% confident interval. The result is just because of renewable energy sources are very expensive, moreover it is not confirmed that the green finance fund is used in only energy sector green finance fund can be used in the other environmental protection related project also, that why green finance shows the negative impact. Financial inclusion, international trade, public spending and natural resources also show negative impact to renewable energy consumption. While technological innovation, FDI and financial development show positive effects on the renewable energy consumption.

1.8.5 Conclusion

Extensive research has been conducted on green finance, energy consumption, and financial aid factors but previous research focused on the specific region this study selects different regions. Earlier studies employ CO_2 emissions as a proxy for sustainable development due to the lack of a single metric to characterize the total environmental performance and climate change. This research contributes to the expanding body of literature regarding green financing and financial aid factors, research and development, foreign direct investment, green technological innovation, and sustainable development. The focus is also on the Asian and European region because maximum countries are selected from these regions due to data availability.

According to research, green finance has been found to boost Sustainable development. Furthermore, it has been proved that Renewable energy use has a good effect on the environment. In spite of this, the environmental performance of selected nations is declining due to rising energy use and foreign direct investment. The outcomes of the study indicate that ASEAN financial institutions have extended loans to environmentally concerned businesses. According to our findings, environmental performance in selected countries can be enhanced by developing and implementing more targeted policies and green financing.

1.9 Structure of the Study

This study is structured in the following way. Chapter 01 explains introduction, background, Problem statement and objective of the study. Chapter 02 will explain the literature review about the variables and research questions of the study. Chapter 03 will explain the research methodology, data composition, analysis tools. Chapter 04 will explain basic data analysis of the study. Chapter 05 will explain the specification analysis of the study and last chapter 06 will give conclusion, implications and policy recommendations.

CHAPTER TWO

LITERATURE REVIEW

To address global environmental challenges, achieving sustainable development and shifting towards renewable energy sources have become essential. As the world grapples with the need for environmentally sustainable economic growth, researchers and policymakers have shifted their focus to comprehending the complicated relationships between sustainable development, renewable energy, and several independent variables. This literature chapter aims to provide a comprehensive review and synthesis of existing scholarly works that investigate the relationships between sustainable development, renewable energy, and key independent variables, such as green finance, financial inclusion, financial development, FDI, international trade, and public spending. In addition, this chapter will examine the mediating effects of technological innovation and the rent of natural resources, which play crucial roles in determining the dynamics between these variables. This chapter aims to cast light on the current understanding of these relationships by examining the existing body of knowledge, identifying research gaps, and laying the groundwork for the empirical investigation conducted in this study.

2.1 Dependent Variable-literature Review

This section provides a comprehensive literature review of sustainable development and renewable energy are dependent variables. This review aims to investigate and synthesize the existing research on the relationship between these variables, providing a foundation for understanding the main determinants, outcomes, and interconnections associated with sustainable development and the adoption of renewable energy.

2.1.1 Sustainable Development (Greenhouse gas emissions)

Global climate change is a significant global issue (L. Yang et al., 2019). Temperatures at the Earth's surface and in the ambient air are reaching higher and more intense levels more frequently than in the past (Łebkowski, 2019). GHG is the primary cause of global warming and air pollution. Increasing conveyance volumes have a more significant detrimental effect on the environment. One of these effects is the air pollution problem induced by the combustion of fossil fuels, agricultural activities, industrial and factory exhaust, and other activities (Knez et al., 2014). In addition to other environmental hazards, GHG emissions negatively impact the environment (Alam et al., 2007). They are emitted by numerous human activities, such as industrial and transportation activities (Sinha et al., 2020). Since the beginning of the industrial period, the generation of greenhouse gases (GHGs) has increased due to human activities. It is common practice to describe the radiative forcing of greenhouse gases in terms of watts per square meter. Greenhouse gases are distinguished by their ability to change the energy balance of the Earth's atmosphere (IPCC, 1996). Radiative forcing (the anticipated influence of the additional unit of gas on the Earth's radiological balance), mean lifespan (the projected length of time that the pressurization by a unit of fuel would persist), and emissions all contribute to the climatic forcing potential (GWP). The term "radiative forcing" describes the predicted impact on Earth's radiation balance of an additional unit of gas (i.e., the total amount of gas emitted). GWP consists of the first two variables. Water vapor, carbon dioxide (CO2), and nitrous oxide (N2O) are all examples of naturally occurring greenhouse gases that trap heat. Hydrofluorocarbons, perfluorocarbons, and sulfosulphur hexafluorides are all examples of man-made greenhouse gases (IPCC, 1996). Carbon dioxide, methane, and nitrous oxide are the principal contributors to rise in radiative forces (IPCC, 1996). Both methane (CH4) and nitrous oxide (N2O) have agriculture as a major source. Carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O) are the three main gases regulated by land management and responsible for the potential greenhouse effect. Carbon dioxide is the most significant of these (contributing 57%) and hence has the most ability to effect climate change. CH4 accounts for 27% and N2O for 16% of the total contribution (CAST, 1992.).

The impacts of human activities on the growth in CO_2 in the atmosphere and the climate changes have been a matter of study for more than a century now. (Tyndal, 1861) proposed that CO_2 could effectively capture heat. Other researchers Arrhenius (1896), Bolin et al. (1959) provided reliable baseline measurements of atmospheric CO2 content, facilitating the tracking of future increases in the gas. improved our knowledge of how CO2 levels in the atmosphere affect global temperatures (Barnola et al., 1987.; Sundquist, 1987) A link among CO_2 and global temperature was proven by data extracted from ice cores that contained historical levels of atmospheric CO_2 concentration. In the 1970s, researchers began to gain better understanding of the global warming potential of other trace gases such as N_2O, CH_4, and chlorofluorocarbons. In the 1980s, the human effect on global warming achieved sufficient credibility to stimulate international political participation, which in turn led to the establishment of the Intergovernmental Panel on Climate Change (J. Houghton et al., 2001). Recent studies Climate Change (2007) J. T. Houghton et al. (2001) have verified the human effect of GHGs on global climate change. Atmospheric concentrations of carbon dioxide were likely between 290 and 295 parts per million before industrialization. CO2 levels have risen to 350 ppm by 1990 (Wood et al. 1990), reaching 370 ppm or higher at monitoring stations operated by the Scripps Institution of Oceanography in 2004 (Keeling & Whorf, 2004). By the end of the 21st century, it is anticipated that the concentration of CO_2 will have reached 500 ppm. According to the IPCC, the concentration of CH_4 in the atmosphere has increased by 145 percent since the beginning of industrialization, and the concentration of N_2O has increased by 15 percent as of 1992 (IPCC, 1996). During the 1990s, there was a discernible drop in the number of emissions of CH_4, but since then, human CH_4 emissions have been on the rise (Bousquet et al., 2006). Between 1979 and 2004, the N_2O concentration increased linearly (Hofmann et al., 2005). Additionally, livestock contributes to the increase in GHG emissions. There is a widespread consensus among scientists that human activities are a contributor to the ongoing change in the global climate, despite the fact that the mechanics of climate interaction are not completely understood (J. T. Houghton et al., 2001). Regardless of their level of economic development, nations have prioritized the regulation of greenhouse gas emissions ever since the United Nations adopted the Millennium Development Goals in the year 2000. Because industrialized nations and countries that have an orientation toward industry have an impact on the environment, it is necessary for them to regulate their emissions. However, after the adoption of the SDGs in 2015, the top organizations in the world and the member states of the United Nations saw a more concentrated and focused approach to the cleaning up and protection of the environment. Between 290 and 295 parts per million (ppm) of CO2 were thought to have existed in the atmosphere before industrialization. The CO2 level reached 350 ppm by 1990 (Schäfer et al., 2015). Skrúcaný et al. (2019) have conducted research on the many policy repercussions and how they would affect the countries of Europe. They highlighted that policies are required for wise sustainability regardless of the level of development in a state.

Other research Sinha et al. (2020) We took a representative sample of Asian and African economies and evaluated how technological advancements and policy changes affected greenhouse gas emissions (GHG) in those nations' environments. They came to the conclusion that nations have increased their focus on the policy processes necessary to achieve sustainability and the SDGs. Since the Sustainable Development Goals (SDGs) were first introduced, scholars have assessed the governmental policy implications of a concentrated perspective and recommended several policy implications for accomplishing all of the SDGs through effective allocation of state resources (Pezzagno et al., 2020). The predicted and observed effects of global climate change include rising sea levels (Shepherd & Wingham, 2007), changes in rainfall distribution and intensification of storms (Climate Change, 2007), and an accelerated rate of species extinction. Estimates put the pre-industrial concentration of CO2 in the air between 290 and 295 ppm. In 1990, atmospheric CO2 levels had already reached 350 ppm (Kimble et al., 2001).

H_1: There is a correlation between the green financial indicators and Sustainable development.

2.1.2 Renewable Energy Consumptions

Growing global industrialisation and excessive exploitation of non-renewable energy sources have led to significant emissions of greenhouse gases. Because of this, global temperatures have risen and many environmental issues have arisen (Wang et al., 2021). Prior to the beginning of the industrial revolution in 1850, the concentration of carbon dioxide (CO_2) in the atmosphere had already increased by 285 to 419 parts per million (Chen et al., 2021). Prior to the beginning of the industrial revolution in 1850, the concentration of carbon dioxide (CO_2) in the atmosphere had already increased by 285 to 419 parts per million (Sangomla, 2022). In addition to this, it is projected that global concentrations of greenhouse gases would rise by a factor of fifty by the year 2050. The primary driver of this growth will be the release of carbon dioxide from energy sources that do not replenish themselves (Rabaey et al., 2014). As a result of rising global industrialisation and the overexploitation of nonrenewable energy sources, significant amounts of greenhouse gases have been released into the atmosphere. The result has been a rise in global average temperature and other environmental issues (Yang et al., 2022).

There are countries on this planet that are home to about 80 percent of the world's population, and these countries are the biggest consumers of fossil fuels (IRENA, 2022) Because of their reliance on fossil fuels sourced from other countries, approximately six billion people are exposed to the possibility of geopolitical upheavals and disasters (Ala'a et al., 2022.). Renewable energy sources are available to every country in the world; yet, only a fraction of their full potential has been tapped thus far. The rapid growth of global industry and the overexploitation of non-renewable energy sources have both contributed to a significant increase in atmospheric concentrations of greenhouse gases. Since then, global temperatures have risen and many environmental issues have arisen as a result (L. Chen et al., 2022). Rising global industrialisation and excessive exploitation of nonrenewable energy sources are major contributors to the release of large quantities of greenhouse gases. As a result, global temperatures have risen and many environmental issues have arisen (Chen et al., 2021). Not only CO_2 emissions be cut, but also CO_2 must be removed by filtration in order to accomplish net-zero carbon or toxic pollutants of carbon. This can be achieved by a variety of economic and social, ecologic, and technological measures. Achievement underlined in the Paris accord and promoting sustainable development depend on this. In order to do so, it is necessary to reduce CO_2 emissions.

Growing global industrialisation and excessive exploitation of nonrenewable energy sources have led to significant emissions of greenhouse gases. Because of this, global temperatures have risen and many environmental issues have arisen (Fawzy et al., 2020). As a result of rising global industrialisation and the overexploitation of nonrenewable energy sources, significant amounts of greenhouse gases have been released into the atmosphere. The result has been a rise in global average temperature and other environmental issues (Bull, 2001). The phrase "renewable energy" is used to describe power that comes from many sources that may replenish themselves over time. Sunlight, wind, water currents, the heat from the earth's interior, and biological matter are all examples of renewable energy. Biomass refers to any organic material that may be burned as fuel, including biofuels, industrial and agricultural waste, and municipal garbage. These assets can provide electricity for the whole economy, fuel for the transportation sector, and thermal energy for residential and industrial usage(Ellabban et al., 2014). The current demand for energy around the world could be met more than 3,000 times by using renewable resources. A need for sustainable power (in the form of electricity, heat, and biofuels) all over the world has increased significantly over the past decade, with the share of renewable sources in global electricity increasing from 27 percent in 2019 to 29 percent in 2020. This increase is due to the fact that the amount of electricity generated from renewable sources is expected to increase (Bouckaert et al., 2021). In spite of the progress made in renewable energy, the rate at which the world is shifting from conventional to renewable energy is too slow, and the planet is not on track to achieve net zero emissions and sustainable development by the year 2050. As a result, greater effort is necessary to change the energy business into a centre that is free of carbon emissions. This is something that can be accomplished through the cooperative efforts of numerous multidisciplinary research teams as well as the incorporation of integrated approaches that are obtained from recent scientific and technological advances in environmental and geotechnical engineering, biotechnology, nanotechnology, and other fields of study.

In addition, Sustainable Energy Development Strategies typically involve three significant technology shifts: savings in energy on the consumer side (Muneer et al., 2005), efficiency improvements in the process of energy production (Lior, 1997), and replacement of fossil fuels with various renewable energy sources (Blok, 2005). Therefore, large-scale renewable energy implementation plans must incorporate strategies for integrating renewable energy sources into cohesive systems of energy influenced by energy savings and efficiency measures (Afgan & Carvalho, 2004). First, increasing the proportion of renewable energy in the supply system is the most significant difficulty. Renewable energy is regarded as a significant asset in many countries around the globe (Huacuz, 2005). However, less than 15% of the world's primary energy supply is produced by renewable sources, with hydropower and wood fuels accounting for most developing nations. Natural sources, such as wind and solar, account for a negligible portion of the total energy supply.

Despite this, there is a significant amount of promise. Over the past few decades, there has been a considerable increase in the percentage of areas and countries that rely on renewable sources of energy. There are two key barriers standing in the way of sustainable development solutions involving renewable energy. It is difficult to successfully incorporate unpredictability into the energy system, particularly the supply of power (Lund, 2006). The second strategy includes the transportation sector (Lund & Münster, 2006). To attain carbon neutrality and effectively support human activities, reducing carbon emissions from fossil fuels and food is of utmost importance while promoting carbon capture and storage in marine and terrestrial ecosystems (H. Cheng, 2020). Diverse nations have mapped out distinct strategic routes to attain carbon neutrality (Pedersen et al., 2020). However, accomplishing net-zero CO_2 emissions is difficult due to the sheer number of the involved fluxes. Following the (IEA, 2023.), It is imperative that all new coal, natural gas, and crude oil extraction and development come to an end in 2021 if the world is to reach its goal of becoming carbon neutral by 2050. Taking this into consideration, investments in renewable energy through C-free sources (such as light from the sun, tide, moisture, wind, wave, rain, and tidal energy) and biomass (materials obtained from farm animals) are the best way to address the gap between the rhetoric and the reality of cumulative CO_2 emissions.

H_4: There is a correlation between the green financial indicators and Renewable Energy Consumption.

2.2 Independent Variable

This section presents a comprehensive literature review on the independent variables. Specifically, this study investigates existing research on green finance, financial inclusion, financial development, foreign direct investment, international trade, and public expenditure. The purpose of this investigation is to give light on the importance of the factors under question.

2..2.1 Green Finance

Recently, a consensus has emerged for the protection of the environment, steps to combat climate change, and the accomplishment of the Sustainable Development Goals (SDGs) of the United Nations by the year 2030. Amidjaya & Widagdo (2020) have pushed environmentally responsible financing to the forefront. Regarding green finance, the terms 'sustainable finance,' 'environment finance,' 'climate finance,' and 'green investment' are used interchangeably. At the eleventh G-20 conference, which took place in Hangzhou, China, in 2016, green finance achieved the pinnacle of its significance (R. Liu et al., 2019), There was a lot of talk about it and it got a lot of publicity. There are a number of perspectives on green finance, each of which represents some aspect of the idea that is significant to the researcher. As a consequence, there are a variety of understandings of, and degrees of interest in, green finance. Although "green finance" is being used more frequently globally, no single definition exists. IFC (2017) defines green finance as "financing of investments which offer environmental benefits," whereas UNFCCC proposes and defines climate finance as "local, national or multinational financing derived from public, private and different types of financing that seeks to support climate change mitigation and adaptation actions." Although their definitions differ slightly, both terms refer to the financial instruments used to combat climate change and promote sustainability. (Lindenberg, 2014) defined the concept as financial institution policies that support the green economy. The 'finance' part of the concept is an illustration of how different financial systems allocate available resources and investment (Berensmann et al., 2017).

In order to foster economic expansion and development, a key role that banks perform is that of intermediaries in the process of absorbing and redistributing unused wealth across society (Andreeva et al., 2018). The term "green finance" refers to the practice of allocating financial resources to social inclusion and corporate governance in addition to climate change mitigation, environmental protection, and renewable energy projects. This "green" characteristic of green finance mandates that this practice take place across all areas of the economy (Urban & Wójcik, 2019). The relevance of environmentally responsible finance is growing in the banking industry as a result of the need to protect banks and society from unforeseen economic issues in the future Ziolo et al., 2019) from unanticipated global financial events, climatic crises, social upheaval, and corporate scandals. Additionally, there has been a paradigm change in conventional banking toward the provision of products that are ecologically advantageous (Dikau & Volz, 2021). The 'finance' component of the concept represents the allocation of money and investment opportunities across diverse monetary structures (J. Y. Kim, 2017).

Urban & Wójcik, (2019), D. Zhang et al., (2019) represent a move on the part of the World Economic Forum to cut off funding for organisations and countries that prioritise economic growth above environmental preservation. Several large banks have lately declared a shift in their strategic business strategies toward the use of environmentally friendly goods. These banks include Société Générale, Singaporean Banking Corporation (HSBC), Deutsche Bank, BNP Paribas, and Credit Agricole, among others. They plan to stop providing financial support to businesses and individuals whose practices are harmful to the environment (Sanchez-Roger et al., 2018)The People's Bank of China is one example of a central bank that has designed and adopted policies to steer sustainable monetary operations in the banking sector (L. He et al., 2019b). Despite the significance of these pacts, it is noteworthy to note that many banks in various regions of the globe have not shown a willingness to produce green financing financial products. This is a primary reason why the notion of "green finance" in its current form has not been accepted in a significant portion of the globe. It has a high risk profile, restricted reach and dimensions, and encounters extra hurdles due to a lack of unified rules and regulations on a worldwide basis.

Recent research examines the correlation of green finance in Environmental Protection. Green finance may influence environmental performance in various ways by stimulating financial support, resource allocation, and technological innovation. The effect of capital assistance demonstrates how green funding can be utilized to improve social and environmental performance. Green financing aims to reduce energy, pollutants, and CO_2 emissions while discouraging excessive pollution and promoting industrialization. In a study by van Veelen, 2021), the incorporation of green credit terms in People's Republic of China financing impacts corporate financing costs. According to their empirical findings, green credit increases the cost of financing for high-emission and high-pollution businesses while decreasing the cost of financing for eco-friendly businesses. (Srivastava et al., 2022) Investigates the macro-mechanistic role of the evolution of green finance and its environmental effects. The impact of green money on environmental sustainability varies by region, according to specialists.

A study discussed GF's role in the market mechanisms green finance system. The research article states that the GF is the financial pattern whose purpose is environmental protection and the sustainable use of resources. However, it depends on the market mechanisms. If the market is rational, GF will help protect the environment Wang et al., 2016.). Another study put light on the features of GF on the SD. The study concluded that the rapidly growing field of “green” finance captures the multidisciplinary approach, the concepts of sustainable development, and responsible financing. It is a perspective and creative orientation for global development and tackling global problems (V Arkhipova,2017).

Green finance and eco-friendly fintech are powerful factors driving the transition to a sustainable economy because they make it possible for technological improvement and industrialization that reduces dependency on polluting energy sources. Green finance and sustainable development benefit from fintech. Implementing new policies to support green finance and fintech should be accelerated (Cen et al., 2018). Green finance is also helpful in decreasing the CO_2 emission by lending green funds to the renewable energy sector. Renewable energy is expensive, and organizations avoid the investment in renewable energy sector. A study concluded that the share of non-fossil electricity increases significantly from 42 to 46% due to green financing. Since gas is more expensive and is up against tougher competition from renewable energy resources, it appears that it is not replacing coal. However, given that GF in our investment modelling of investments is only represented as avoided investment in fossil-based businesses, this move towards renewable energy may be somewhat understated (Glomsrød et al.,2018). The challenges posed by the environment and the management of natural resources can be overcome with the assistance of green financing and market processes (Narayan et al., 2022). Financing that is friendly to the environment and more environmentally friendly gives opportunities and rewards (Meher et al., 2020).

N. Zhang et al., 2017) additionally looked at the factors that contribute to geographic transfer's influence and diversity in China's eastern, central, and western regions. They widen the study's scope and subject matter, which allows them to give a basis for designing sustainable funding to assist regional green development. Green finance makes green economic development easier to achieve, which ultimately results in greener GDP growth (X. Wang et al., 2020). Expanding the green industry's investment and financing opportunities is a critical stage in the process of developing a green economy. This is necessary in order to complement the direction and help provided by the government for the sector (Du et al., 2022). Therefore, green financing can be utilized to accomplish comprehensive green development since it helps mitigate the negative effects of changes in the environment and builds resilience against such effects (Prajapati et al., 2021). Every financial institution had to offer green products for sustainable development. This investment approach will help achieve the Goals Of Sustainable Development, particularly SDG 7, SDG 8, SDG 9, and SDG 13 (Desalegn & Tangl, 2022).

2.2.2 Financial inclusion

The process of ensuring that people, especially those who are economically disadvantaged, have access to basic financial services offered by the formal banking system is referred to as "financial inclusion"(Allen et al., 2016). Policymakers and researchers have focused a significant amount of attention on financial inclusion for the following four reasons. First, one of the most important strategies for accomplishing the sustainable development goals set by the United Nations is expanding access to financial services (Demirgüç-Kunt & Singer, 2017); Two, the presence of financial inclusion contributes to an increase in the degree to which many cultures are socially inclusive (Bold et al., 2012); Thirdly, the inclusion of financial services can help bring down the rate of poverty to a more manageable level (Chibba, 2009); and Fourthly, to address the problem of social and economic marginalization (Andrianaivo & Kpodar, 2011), Policymakers in a number of nations continue to commit substantial resources to boosting the amount of financial inclusion in their respective nations.

There have been numerous studies on various aspects of financial inclusion, including its role in fostering development (Ghosh, 2013); its impact on financial stability (Cull et al., 2012); its connection to economic expansion (D. W. Kim et al., 2018); and the practices of individual nations in this area (Mitton, 2008). Widespread consensus holds that reducing barriers to entry for low-income people to the financial system is one of the most effective ways to reduce poverty and economic disparity (Beck et al., 2007). Demirgüç-Kunt & Singer, 2017) It is important to keep in mind, however, that the vast majority of information on the connection between financial inclusion and growth exists at the individual and micro levels. The link underlying FI and broad economic growth remains poorly documented. It is possible, at least in theory, to show a connection between financial inclusion, macroeconomic development, and inequality. This correlation is not black and white, however, as the world bank points out. According to the literature, entrepreneurial endeavor is a function of the capacity and not parental wealth (Demirgüç-Kunt & Levine, 2009). This indicates that in an ideal world, economic actors who have the greatest potential for entrepreneurialism always had access to financial resources so that they can support the ventures they create.

Despite the fact that certain studies Beck et al., 2007) imply that improved access to credit aids in poverty reduction, the researchers behind these studies do not reach any strong conclusions about whether or not financial inclusion actually promotes poverty reduction. Increasing low-income people's access to credit has a significant and positive influence on economic growth, as Bruhn & Love, 2014) demonstrate. In a separate context, Burgess & Pande, 2005) discovered that the proliferation of bank branches in rural India had a significant impact on poverty reduction. Using state-level variables on financial depth, branch penetration, and poverty in 15 Indian states from 1983 to 2005, Ayyagari et al., 2013) discovered contradictory results. These data indicate that financial development since 1991 after financial deregulation is negatively correlated with rural poverty. They discovered that the effects of alleviating poverty were greatest among rural self-employed individuals.

It's worth noting that many banks in various regions of the globe have not shown any signs of willingness to build green financing financial products, despite the significance of these agreements. As a direct consequence, a significant portion of the world's regions have not accepted the notion of "green finance" in its current form. It has a high risk profile, a small footprint, and restricted reach and dimensions, among other problems on a worldwide scale Al-Mulali et al., 2015) between the years 1990 and 2013. Except for trade openness, all of the aforementioned factors were found to accelerate environmental deterioration. Using annual data from 1972 to 2013, Javid & Sharif, 2016a) CO2 emissions in Pakistan were analysed in relation to the country's expanding economy, energy use, and GDP.CO2 emissions in Pakistan were analysed in relation to the country's expanding economy, energy use, and GDP. All independent variables were found to increase pollution when analyzed using the ARDL model. Financial development was found to moderate the effect of EKC validation in Turkey by (Katircioğlu & Taşpinar, 2017). After using main effects and interaction effect simulations, which demonstrated that financial development tempered the positive influence of actual GDP on CO_2 emissions over the long term, the EKC hypothesis was verified. This was done so since the models showed that it happened. Furthermore, the results supported the EKC theory. Deforestation in developing nations was studied by Combes et al., 2018), who looked into the impact of capital availability. Deforestation was found to rise when people had easier access to capital. Tsurumi & Managi, 2014) used data from 1990 to 2003 to examine the openness-deforestation relationship for OECD and non-OECD economies. Trade openness was found to increase deforestation in non-OECD countries while decreasing it in OECD countries. CO_2 emissions may be impacted positively or negatively by financial inclusion. The study demonstrates the detrimental effects of financial inclusion on global warming L. Qin et al., 2021). This negative result doesn’t mean that financial inclusion should be reduced, there is need of policy rearranging. There is an understanding that a lack of financial accessibility has a opposite influence on economic growth and poverty reduction because it makes it impossible for the poor to save money, create assets to fend against hazards, and invest in ventures that will generate income D. Cumming et al., 2014).

However, other research found that improved environmental quality was a result of increased financial development and financial inclusion. The impact of monetary growth and GDP expansion on BRICS countries' CO_2 emissions from 1992 to 2004 was analyzed by (Tamazian et al., 2009a). CO_2 emissions were positively connected with GDP and negatively correlated with financial development. Both Dogan & Seker, 2016a) discovered a significant and favorable link between economic security and ecological health. Using the CUP-FM and CUP-BC techniques,Zafar et al., 2019a) analyzed the connection between increased economic activity and, globalization, and pollution in OECD countries. Both economic growth and more globalizations have been linked to lower levels of pollution over time. Both Renzhi & Baek, 2020a) verified the EKC system that is based on financial inclusion for the panel of 103 nations and found that it had a favorable impact on CO2 emissions. Using different measures of financial inclusion as proxy, researchers uncovered a link between the two that was in the shape of an upside-down U. Another study concluded that the FI has a beneficial effect on economic expansion (D. W. Kim et al., 2018). Financial inclusion increases energy use, which directly increases CO_2 emissions (Zaidi, Hussain, & Uz Zaman, 2021). evaluated how the country's expanding economy, energy use, and GDP affected CO2 emissions (Odugbesan et al., 2022). In the literature there is a mixture of results, so this study is going to investigate the interaction between financial inclusion and environmental degradation.

2.2.3 Financial development

" What is meant by "financial development" is "the forces, regulations, and institutions that support successful financial intermediaries and marketplaces, as well as fundamental and widespread access to money and financial services"(WEF, 2011). In a similar spirit, Levine, 1999) proposes that " The financial system's capacity to research companies to discover profitable projects, exert corporate authority, control risk, utilize savings, and facilitate transactions. " Is an ideal indicator of financial progress. The importance of efficient financial intermediaries and stock markets is emphasized by these definitions. However, in order for these definitions to be useful in empirical studies, this may be the literature's biggest problem (Edwards, 1996). The use of conventional metrics, such as the ratio of credit to GDP (gross domestic product), makes some implicit assumptions, such as that strong credit growth implies efficient financial intermediation. In contrast, rapid expansion of credit may portend an imminent economic disaster due to misallocation of funds.

The empirical studies in this field first concentrated on financial institutions. Stock market impact studies followed (Atje & Jovanovic, 1993), and since then, there has been widespread acceptance of proxies for the growth of the stock market. The most common metrics for gauging the growth of a stock market are the market cap ratio (J.-S. Yu et al., 2012), stock exchange activity (C.-H. Shen et al., 2011), and the total assets turnover (Yay & Oktayer, 2009). All three of these metrics have been developed in recent years. tallied the CO2 increases caused by an increase in the country's GDP, energy use, and banking sector.

The financial sector and financial stability are crucial to the real economy and are a hotly contested topic in economics. Financial development is frequently highlighted as a key factor in economic growth in emerging economies, it is possible that this factor has an impact on energy demand (Sadorsky, 2010a). The literature is full of discussions of the correlation between financial advancement and economic expansion. Conceptually, this body of work can be traced back to the writings of economists like (McKinnon, 1973b), All of whom contended that an increase in the number of financial intermediaries such as banks would stimulate economic expansion by enhancing the distribution of available resources and encouraging technological innovation in manufacturing. According to the findings of a number of empirical research, there is a considerable relationship between improvements in one's financial situation and overall economic development. In accordance with the findings presented in the sections King & Levine, 1993) it was hypothesized that a more advanced and well-developed financial system would increase productivity by making the creation of an endogenous growth model easier. Using information on six developed countries from the years 1850 through 1997, (Rousseau & Sylla, 2003) conducted a cross-country regression, and their findings showed that financial development had a significant impact on economic growth, especially in the eighty years leading up to the Great Depression. As the literature shows, Financial Development promotes faster economic expansion. Theoretically, variations in the number and caliber of financial institutions to play the importance part in influencing economic growth. In more detail, there are two distinct ways that financial development can spur economic expansion (Fung, 2009).

However, research suggests the connection between financial liberalization measures and economic growth is not as clear as once thought (Sassi & Goaied, 2013). The crises of global economy of 2008-2009 showed the pernicious effects of broken financial institutions, which can lead to resource waste, reduced savings, increased speculation, decreased investment, and a misallocation of limited resources. Although many believe that a positive financial-growth relationship exists, certain empirical research has found otherwise. Ram, 1999), using data from 95 nations, demonstrated that the relationship between FD and economic growth was either weakly negative or not statistically significant. If private sector credit is greater than 100% of GDP, then FD has an adverse effect on GDP growth, as argued by Arcand et al. (2012). According to the findings of Samargandi et al., 2015), there is a U-shaped link with an inverted form that exists between finance and growth over the long term, and this relationship will have a negative effect on economic growth if there is an excessive amount of finance, who analyzed the non-monotonic effect in middle-income nations from 1980 to 2008 by using a threshold model. Using a sample of 26 countries that were members of the European Union during the years 1990. Asteriou & Spanos, 2019) To investigate how the global financial crisis of 2008 affected the relationship between financial development and economic growth, multiplicative dummies were employed in the research. Another study states that the FD can lead to the energy consumption in the emerging economies which can lead toward the high Co2 emissions (Sadorsky, 2010a). A study uses the financial development in terms of investor protection. This study was conducted in China.

According to a study, investor protection and financial development go hand in hand; on the other hand, extensive government intervention causes more financial barriers. Additionally, government involvement in education could encourage financial development by helping to increase the supply of funds (Chu et al., 2017).

After the formation of SGDs, world research shifted toward the sustainable development. In recent times, researcher trying the contribute toward the sustainable environment. Recent studies show that empirical research on the effects of FD on the environment has sparked interest and been met with resistance. Environmental performance benefits from FD. In all sub-Saharan Africa, FD is inversely correlated with environmental sustainability. However, the argument that inadequate indigenous institutions make it difficult to produce great economic success and sustainable environmental quality is strongly endorsed (Jibrilla, 2018). Environmental stability on a financial and ecological level is another significant factor. Environmental deterioration and GHGs emissions decrease as a result of financial development. According to the study's conclusion, financial stability and environmental sustainability are two sides of the same coin (Shahbaz et al., 2018a). Indirectly or directly, a country's CO_2 emissions rise as its economic development and trade improve, because exports improve with greater financial development and (R&D) (Dzankar Zoaka et al., 2022). Literature shows that the FD has adverse impact on the Environment but when financial development is planned than it can have positive impact. In this study we will investigate impact financial development in terms of green finance on environment.

2..2.4 Foreign Direct Investment (FDI)

The international monetary firm gives definition of FDI is the most widely used. The acquisition of at least ten percent of the voting power or common shares in a public or private firm by nonresident investors is what the IMF classifies as FDI. Reinvesting earnings is a form of FDI that entails a long-term stake in the management of an organization (Agrawal & Khan, 2011). The contribution of FDI to green growth has got little consideration in recent years. However, FDI has the potential to be highly significant for two reasons. First, FDI is an essential source of funding because of its size and rapid rise over the past few decades. Looking at financial transfers from industrialized to poor nations that are pertinent to climate change (Golub et al., 2011).

The link between foreign FDI and GDP growth is a popular topic among academics worldwide (Vo et al., 2019). There is a consensus among most people that this link has been exhaustively researched, with either data from a single nation or a fair representation from a large number of nations. Regrettably, there is not a lot of agreement among academics regarding the outcomes of empirical research. For a case study of a single nation, Koojaroenprasit (2012) analysis of FDI's effect on South Korea's economic expansion from 1980 to 2009. FDI was found to have a significant favorable effect on Korea's economic growth, with further positive effects observed for human capital, exports, and employment. Long-term favorable effects of foreign capital flow on economic growth were also shown in Pakistan (Shahbaz & Rahman, 2010).

In past studies the role of FDI was considered in different contexts. A study Jyun-Yi & Chih-Chiang (2008) conducted in China and India and concluded that FDI encourages economic expansion and, according to estimates, a 1% increase in FDI would raise China's GDP by 0.07% and India's GDP by 0.02%. Additionally, the research reveals that FDI had a greater effect on growth. A key component of globalization, FDI is recognized as a significant driver of increased productivity, technological advancement, and job creation. However, FDI could be discouraged if institutional quality were to decline. The relationship between foreign direct investment and GDP per capita was found to be nonlinear. All of the Worldwide Governance Indicators pointed to a positive correlation between high levels of institutional quality and rising economic output, with the exception of political stability and the presence of both violent and terrorist acts. In addition, variables such as economic inequality, poverty, technology, development, transportation infrastructure, and technology were considered to be major growth drivers (Gherghina et al., 2019). (Tiwari & Mutascu (2011) noted that FDI and international trade contributed to the economic development of 23 Asian nations between 1986 and 2008. They found, critically, that FDI significantly affects economic growth and development (Borensztein et al., 1998) investigated the impact of FDI on economic development in developing nations. They found that foreign direct investment (FDI) significantly affects economic growth and development, which is a crucial finding Omran & Bolbol (2003) demonstrated an elevated correlation as well as significant causation between FDI and economic growth in Arab nations. They found that foreign direct investment (FDI) significantly affects economic growth and development (Alfaro et al., 2004), They found that foreign direct investment (FDI) significantly influences economic growth and development, which is crucial.

In contrast to the previously reported favorable connection across FDI and economic growth for data across nations, an adverse relationship was discovered, adding a significant piece to the (unsolved) puzzle. Jyun-Yi & Chih-Chiang (2008) found no correlation between foreign direct investment and growth in the economy for 62 countries during the period 1975–2000. Similarly, Lyroudi et al. (2004) discovered that FDI had no effect on the economic development of emerging markets between 1995 and 1998. Caporale et al. (2015) are among the authors who have emphasized the link between for FDIs and output/consumption volatility. From 1960 to 1999, Kose et al. (2003) found a favorable correlation between increasing financial openness and the increasing volatility of consumption in developing countries.Kose et al. (2009) explored how financial globalization benefited nations. During the period of globalization, they discovered that industrial nations had achieved a higher level of risk sharing than emerging markets.

A recent study by C. Xu et al. (2021) indicates a destructive correlation between FDI and income. According to their findings, the connection between FDI and income inequality is significant. Aust et al. (2020) conducted empirical research to examine the link between FDI and the attainment of Sustainable Development Goals (SDGs) for 44 emerging African economies, differentiated by region, for the period 2015 to 2018. Their research indicates that FDI flows have a positive effect on the attainment of Sustainable Development objectives. However, they also emphasize that the presence of FDI can have negative effects on the environment of FDI recipient countries. According to the evidence presented in their paper, FDI has a negative impact on the achievement of SDG13 (Climate action). They find that the availability of FDI increases the likelihood of attaining an overall SDG index score in Africa, which encourages additional investment in Africa. However, the authors also acknowledge the negative environmental effects of FDI. A study conducted in the Kuwait which considered the role of FDI in the sustainable environment. The study shows that according to the VECM Granger causality test, CO_2 emissions are strongly Granger-caused by FDI, electricity use, and economic expansion (Salahuddin et al., 2018). The result indicates that as FDI increases, CO_2 emissions will also increase. Another research conducted in the Indian context demonstrates an adverse correlation among energy consumption and FDI over the long term. Given that FDI has a destructive effect on CO_2 emissions, it is crucial to implement energy-saving technologies. The findings indicate that FDI reduces nonrenewable energy consumption over time. The direction of causality indicates a positive feedback relationship between economic output, foreign (Nepal et al., 2021). By analyzing the descriptive statistics, it has been determined that FDI has increased economic growth and improved social welfare for workers, institution quality, and labor skill (NN Tien et al, 2022.).

The majority of research papers provide evidence of a favorable link between FDI and economic growth, but some authors emphasize the negative impact of FDI flows on both the environmental and social development of the host economy.

2.2.5 International Trade

International trade is a strategic endeavor for the expansion of a developing economy. International specialism is the production of various items by various nations of the world. The creation and implementation of trade policies that address issues including tariffs, subsidies, quotas, taxes, customs and administration, public procurement systems, aid and investment, export promotion, trade facilitation, and diversification. Several studies have been investigated on the significance of global trade as well as their impact on a number of different topics (Makhloufi & Vijayasri, 2013).

International trade can flourish when governmental policies and economic infrastructure are adaptable enough to consider the consequent changes in the social and financial environment promotes economic growth (Makhloufi & Vijayasri, 2013). the study shows that, both from a manufacturing and consumption standpoint, international trade is a key element in understanding the shift in emissions in many nations (Peters et al., 2011a). Another study which shows the impact of international trade with institutional perspective. There is a "race to the top" in institutional quality when nations share the same technology, forcing both trade partners to upgrade their institutions after openness. On the other hand, when one of the countries possesses a significant enough technological comparative advantage in the institutionally intensive good, neither country's internal institutions will advance. Even though the time series findings are not statistically significant, the model's corresponding cross-sectional forecast matches the data. The institutional quality is noticeably greater in nations whose exogenous geographic traits predisposition them to exporting in institutionally demanding sectors Levchenko, 2013).

Another study shows the role of international trade in heterogeneity of firms. The export, exit, and process innovation decisions of heterogeneous companies can be significantly impacted by changes in trade costs; In most cases, product innovation counteracts the negative effects of these decisions on welfare (Atkeson & Burstein, 2010).

As internationally tradable commodities, natural resource flows are influenced by the trade policies of multiple nations. Environmental policies, particularly those intended to regulate the extraction and utilization of NRR, can have a significant influence on the domestic market. Furthermore, these influence would contribute to changes in the global supply and demand for natural resources. The direction and magnitude of effects may vary between policies, and a combination of appropriate policy options can help break the present resource feedback loops, which is essential for sustainable development (G. S. Cumming & von Cramon-Taubadel, 2018). Such quantifiable information can assist policymakers in managing natural resource trade-offs more effectively. The development of global supply chains and an open trade policy have simplified international trade in resources over the recent several decades (Timmer et al., 2014). However, the international mobility of production factors also redistributes negative externalities. According to Arrow et al. (1995), the environmental costs are frequently borne by impoverished countries and future generations. Significant literature on consumption-based tracking of emissions (Peters et al., 2011b), international transfer of emissions, and aggregate embodied intensity Su & Ang (2017) has extensively documented this effect. Not even natural resources are exempt. Wiedmann et al. (2015) found that as prosperity increases, developed economies tend to increase their material consumption while decreasing their domestic material extraction through international trade. In international trade flows, it is necessary to differentiate among emerging economies and more developed countries, and the effects of policy instruments and other driving factors may vary. However, these previous studies are founded on an input-output framework and cannot account for crucial factors such as policies and institutions (Zhong et al., 2022).

They found, critically, that FDI significantly affects economic growth and development. They found, critically, that FDI significantly affects economic growth and development Cerdeira Bento & Moutinho (2016). Nonrenewable energy and carbon dioxide are created in international trade on a per-person basis. Furthermore, the findings show that renewable electricity generation is positively associated with GDP per capita and negatively associated with nonrenewable electricity production.These findings indicate that increasing trade and using renewable energy sources are effective ways for these nations to tackle global warming Jebli et al. (2016a). (Dou et al.,2021) investigated the influence of trade openness on the amount of greenhouse emissions and found that imports increase GHGs emissions while exports decrease them. Ali et al. (2021) found the contrary to be true for Indonesia. The research revealed that exports tend to raise GHG emissions, whereas imports reduce them. In the available literature, the association between international trade (IT) and Environmental degradation (ED) is well-established. Surprisingly, there is no consensus among academics about the role of IT in the ED.

2.2.6 Public Spending

In recent years, the education sector has undergone significant reform initiatives in a number of nations, driven by the belief that there is a connection between educational achievement and economic growth. Public spending in this area has increased by an average of one-fifth in real terms over the past decade, and several nations have experienced significant increases in spending per student (Sutherland et al., 2009). Another study investigates the role of public spending in the education in the context of rich and poor countries. The study reveals that more equal income distribution is linked to increased public spending on redistribution and higher educational accomplishment. It also considers the contribution made by educational attainment, spending, and quality of national institutions. Better institutions and education are said to enable more effective monitoring and control of public expenditures, less rent-seeking and leakage, and more equitable income distribution for a given expenditure (Afonso et al., 2010).

A study shows the influence of public spending on the Economic growth. Another study demonstrates that, across a wide variety of countries' income levels, reallocating investment away from health and social protection and toward education has a strong growth-promoting impact. However, when reallocating funds for infrastructure spending, income heterogeneity affects. In particular, reallocating this investment to education also fosters growth, but mostly in low-income countries. This is because, probably as a result of the poor quality of governance, the effects of infrastructure spending are especially modest in low-income countries (Acosta-Ormaechea & Morozumi, 2017). The study reveals that, Trade openness, private investment, and government spending on capital formation all have a beneficial and considerable effect on economic growth. Both the population growth rate and the official development aid are statistically insignificant Yasin (2011). According to international research on the production of education, schools are crucial for student outcomes but less so for conventional inputs. In contrast, teacher quality and incentive-based institutional frameworks have a significant impact on schools. Institutional characteristics of educational systems can provide a substantial explanation for the differences in student achievement between nations.

Another study Agasisti (2014) reveals that While GDPPC is adversely correlated with effectiveness, teachers' salaries, and Internet use (as a proxy for technical "literacy") have a beneficial impact on educational success. Over the past 20 years, they have significantly increased their public energy R&D funding to advance the advancement of renewable technology. Additionally, energy innovation accounts for around 4-8% of total industrial exports, around 5.5% of overall revenues, and a major portion of employment in these nations (Miremadi et al., 2019). The beneficial influence of such funding on innovation is diminished by the unpredictability of variation in public spending on new energy innovation and technology. Nations with fractionalized administrations can improve the success of their green technology projects by implementing institutional measures that reduce the precariousness of public spending. In a similar vein, the findings suggest that both left- and right-wing administrations can improve the success of public technology initiatives by reaching treaties that distribute profits in a manner that prevents spending cuts due to political movements (Baccini & Urpelainen, 2012). Public expenditures on human capital and R&D of green energy technologies stimulate a sustainable economy through labor- and technology-focused production activities and distinct impacts in other nations (D. Zhang, Mohsin, Rasheed, et al., 2021.). As study suggest the public spending has different effect t in different nations so this study is going to investigate this relation on different countries.

2.3 Inter Variable- Literature Review

In this section, this study investigates the relationship between the independent variables (green finance, financial inclusion, financial development, FDI, international trade, and public expenditure) and the dependent variables (sustainable development and renewable energy). Examining the impact of these explanatory variables on the achievement of sustainable development objectives and the development of renewable energy adoption is the objective.

2.3.1 Green Finance and Sustainable Development (GHGs Emissions) Nexus

In 2015, 178 countries participated in the process of signing the Paris Agreement. According to projections made by the IEA in 2014, a total investment of 53 trillion dollars will be necessary between now and 2035 in order to maintain the rate of global warming below the threshold of 2 degrees Celsius that was established by the Paris Agreement. In the meantime, the total value over all shares that were traded on the stock exchanges around the world reached $68.212 trillion in the year 2018. The obvious solution to this enormous funding gap is the utilization of financial capital (Clark et al., 2018). Scholtens (2017) claimed that the rapid rise of financial innovation has a huge impact on several aspects of human civilization but only a little influence on the environment. environmental; hence, there is a vast chance to boost ecological environment utilizing financial capital. Nonrenewable energy and CO_2 emissions are generated per person as a result of international trade. Long-term unidirectional Granger causation is also shown between GDP per capita and green electricity generation, and between non-renewable power generation and green electricity generation Y. Wang & Zhi (2016a) Each person involved in international trade uses more nonrenewable power and releases more CO_2. The findings also show that renewable electricity production is positively associated with GDP per capita and negatively associated with nonrenewable electricity production (Taghizadeh-Hesary & Yoshino, 2019), One person's worth of nonrenewable electricity and CO_2 emissions is generated by international trade. Furthermore, the results show that renewable electricity production is positively associated with GDP per capita and negatively associated with non-renewable electricity production (Owen et al., 2018).

The financial sector has its own positive impact on the environment. This is due to the fact that, on the one hand, the financial sector can provide financial aid for environmentally friendly enterprises and initiatives, and, on the other, financial development can promote the upgrading of infrastructure, which plays a significant role in minimising the use of energy and carbon emissions. This is due to the fact that, on the one hand, stock market growth may encourage the upgrading of industrial structure and, on the other, the banking system can only give financial aid for environmentally friendly firms and projects Nasreen et al. (2017) Based on the data of 23 countries with the highest use of renewable energy, According to the findings of a study Dogan & Seker (2016b), financial development has the potential to successfully cut domestic carbon dioxide emissions.. Guo et al. (2019) The financial sector makes its own contribution to the betterment of environmental quality. This is due to the fact that, on the one hand, the financial sector can provide financial support for environmentally friendly enterprises and initiatives, and, on the other, financial development can promote the upgrading of infrastructure, which plays a significant role in minimising the use of energy and carbon emissions. This is because, on the one hand, the banking system can only support ecologically friendly businesses and projects, while, on the other, the growth of the stock market may encourage the modernization of the industrial structure (Yin et al., 2019a), and nitrogen oxides. As a result, the importance of building green finance rests in improving the aspects of finance that can improve the quality of the environment (Nassani, Aldakhil, Abro, et al., 2017). Poberezhna (2018) explored the potential advantages that a renewable energy industry and blockchain technology could offer in terms of alleviating the problem of water scarcity around the world and lowering the risk of environmental destruction.

Gianfrate & Peri (2019) suggest that it has been claimed that green bonds are among the most essential mechanisms for mobilizing financial resources in order to accomplish the carbon reduction goals set forth in the Paris Agreement.

According to Glomsrød & Wei (2018) As a result of the expansion in green financing, 4.7 gigatons (Gt) of carbon dioxide can be saved from being emitted into the environment by the year 2030, and the percentage of power that comes from non-fossil energy sources can climb from 42 to 46 percent. In actuality, green financing does not have an effect on the quality of the environment; nevertheless, it does help environmentally friendly enterprises and projects succeed, which in turn improves the quality of the environment. As a direct consequence of this, the capacity of businesses with high pollution levels to obtain funding has dramatically shrunk (X. Liu et al., 2019); When compared with typical projects, initiatives that focus on environmental sustainability can result in larger profits; therefore, the issuance of green bonds gives benefits for shareholders, which will encourage corporations to pursue green-related fields(X. Liu et al., 2019); and Compared to more conventional initiatives, environmentally conscious projects that concentrate on Compared to more conventional initiatives, environmentally conscious projects that concentrate on environmental sustainability (Romano et al., 2017) The government's green finance initiatives may increase investments in the renewable energy sector.

However, the views of some scholars diverge from those held by the majority. For instance, S. He (2019) found that growing green finance has a chilling impact on banks' willingness to provide loans, which in turn diminishes the effectiveness of renewables and harms the environment Pacca et al. (2020.) bank loan issuance is negatively impacted by the growth of green finance, which in turn decreases the efficiency of renewables and has a negative impact on environmental quality.

The "green finance development index" was used to investigate the effect of green finance on environmental performance in China from 2010 to 2017, and the results suggested that green finance may be able to help support improvements in environmental quality (Zhou, Tang, et al., 2020). J. Li et al. (2022) examined the connection between green finance and the natural world by conducting an analysis of data obtained from panel surveys conducted in Mexico, Indonesia, Turkey, and Nigeria between the years 1990 and 2020. The data were analyzed using the criterion of "environmental protection products by residents" in order to evaluate green financing. They made the discovery that environmentally responsible funding is an efficient way to stop the deterioration of the environment. Similarly, W. Li & Jia (2017) hypothesized that green finance is the most efficient method for reducing environmental deprivation. Through 2030, (Glomsrød & Wei, 2018) It is anticipated that environmentally friendly financing, in particular the use of green bonds as a proxy, will result in a 2.5 percent reduction in the consumption of fossil fuels, coal. Moreover, Khattak & Ahmad (2022) reported it has been claimed that the creation of environmentally friendly and sustainable technology helps to slow the destruction of the environment in a variety of places.

H_1a: Green Finance has positive impact Sustainable Development.

2.3.2 Financial Inclusion and Sustainable Development Nexus

Since the Maya Manifesto and the G-20 Financial Inclusion Plan (Klapper & Demirguc-Kunt, 2012), the topic of financial inclusion has garnered a great deal of attention in recent years. Policymakers and academics have emphasized financial inclusion for numerous reasons. Ozili (2021) proposes four significant causes. First, as a strategy of the (UN) sustainable development objectives (Klapper et al., 2017); second, in connection with social inclusion (Bold et al., 2012b);

third, to decrease the level of poverty (Beck et al., 2007) and lastly, in relation to socioeconomic benefits (Sarma & Pais, 2011). Theoretically, academicians concur that FI has a significant role in enhancing economic growth (McKinnon, 1973a). There is no question that FI is an essential basis for economic development, as it ensures the creation of capital through distribution, pooling, and savings, and enhances the comprehension of the investment processes and allocation of resources efficiency. The financial sector also plays a significant role in decreasing energy emissions by promoting technological advancements in energy supply to reduce pollution (Jensen, 1996a). While studies have focused on the monetary benefits of financial inclusion, less attention has been paid to how it relates to greenhouse gas emissions.

Theoretically, both benefits and drawbacks on CO_2 emissions could result from financial inclusion. On the one hand, wealth creation makes it easier for individuals and enterprises to access practical and affordable financial plans, which increases the viability of investments in renewable technologies. This is because inclusive financial systems promote improved environmental practises that lessen climate change contributions by making them more widely available, affordable, and adopted (IPA 2017). For farmers in poor areas who might not have access to finance or credit to engage in renewable energy technologies like solar energy microgrids, which are not only cost-effective but also produce significantly less CO_2 than burning coal, the promotion of financial inclusion is crucial. (IPA 2017). (Baulch et al., 2021.) the adoption of solar household systems in Ho Chi Minh City is hindered by financial restrictions (limited access to money, a lack of assistance from the government, and limited bank financing choices) (Vietnam). These are typical scenarios where the provision of affordable financial goods and services may encourage the use of renewable energies and the deployment of environmental protection services, which lower CO_2 emissions by reducing the consumption of fossil fuels. (T. H. Le et al., 2020) In 31 different countries, the consequences of FDI, urban sprawl, power consumption, and industrialization were examined and studied. The study examined data from 2004 to 2014 and discovered an increased trend in both carbon dioxide emissions and financial inclusion. Financial inclusion's effect on carbon footprint was assessed by (Renzhi & Baek, 2020) for 103 countries. The study used data gathered annually between 2004 and 2014 and the GMM approach to demonstrate how financial inclusion reduces CO_2 emissions. It has been demonstrated that raising people's understanding of environmental issues through financial inclusion can help decrease the harmful effects of economic expansion. Zaidi et al. (2021) employing annual data from 2004 to 2014, researchers examined the dynamic consequences of economic cooperation and development. Experts have demonstrated that having access to financing can reduce carbon emissions both now and in the future. Low demographics and skills are caused by inadequate financial and communication infrastructure. For all parties involved, financial education in these domains should be a top focus (Aziz & Naima, 2021). The findings suggest that financial inclusion, which refers to the true accessibility of financial assets by stock markets and banks for financing networks and fruitful projects, can play a significant and advantageous role in the effort to prevent environmental damage, particularly through reducing ecological damage. Therefore, financial inclusion slows down environmental destruction. FDI can be attracted, and environmental quality can be enhanced by investing in renewable energy sources, which also starts research and development and expands business operations (Frankel & Romer, 1999a). reduced financing costs A strong financial industry contributes to less oil pollution, streamlined procurement processes, and other benefits (Kirikkaleli & Adebayo, 2021).

However, the expansion of industrial activities is one way in which FI degrades the environment (Jensen, 1996). T. H. Le et al. (2020) revealed confirmation of FI causing harmful environmental influenced by increasing CO_2 emissions in specified Asian nations, contradicting the findings of the aforementioned research that FI causes GHGs emission-impeding effects. Enhancing FI increases the danger of encouraging greater emissions of GHGs throughout South Asia, as shown in the instances of selected South Asian nations(Amin et al., 2022). FI increases GHGs emissions in OIC member countries, as noted by (Chaudhry et al., 2022), which also draws connections between FI and many measures of environmental quality. In addition to increasing carbon dioxide (CO_2) emissions, the authors also noted an increase in methane (a more potent greenhouse gas) emissions as a result of greater FI. Furthermore, (D. Liu et al., 2022), which examined the effects of FI on GHGs emissions in five developing Asian countries, found that this effect varied according on the indicator used to measure FI. Increasing insurance premiums are likely to reduce GHGs emissions, while increasing the number of branches of commercial banks and bank credits increases CO_2 emissions. While there has been a lot of attention paid to the literature on the topic of financial inclusion and greenhouse gas emissions in recent years, most research on the connection between the financial sector and environmental impacts has focused on FD as an indicator of the quality of the financial sector. FD has been reported to have ambiguous effects on CO_2 emissions much like financial inclusion (Khoshnevis Yazdi & Ghorchi Beygi, 2018; B. Zhao & Yang, 2020).

Empirical evidence between environmental deterioration and financial inclusion is contradictory. The impact of financial inclusiveness on ghgs is examined in this study. We specifically look into whether providing adequate financial products to all individuals, especially those from the most vulnerable parts of society, helps the area's greenhouse gas emissions decline.

H_1b: Financial inclusion is interlinked with stainable development.

2.3.3 Financial Development and Sustainable Development

Financial developments play important role in promoting sustainable development. A recent study finding indicate that the financial sector greatly contributes to changing the structure of energy. In order to promote RNE, FD is crucial (Ji & Zhang, 2019a). Another study conducted in India which states that Long-term determinants of India's utilization of renewable energy include financial development and economic expansion. Long-term consumption of RE, GDP, and financial development are all correlated in a single direction by unidirectional causal links (Erin et al., 2019) Another research that was carried out in EU countries. The study's findings show a strong correlation between the use of RNE and FD. A 1% rise in the degree of FD of the banking sector and, separately, the bond market is related with a 0.0284% and 0.0148% increase in There consumption, respectively, according to the empirical findings. Overall, our findings suggest that the growth of the banking industry, the capital market, and the bond market can facilitate the adoption of green technologies in the energy sector (Anton & Afloarei Nucu, 2020). Indirectly or directly, a country's CO_2 emissions rise as its economic development and trade improve, because exports improve with greater FD and R&D (Dzankar Zoaka et al., 2022).

Taking the classic research of (Grossman & Krueger, 1995), a great number of research have been conducted to investigate the linear and nonlinear connections that exist between the destruction of the environment and the expansion of the economy. The authors contend that initial phases of economic development are associated with a rise in carbon dioxide emissions, but that sustained growth over a specific threshold is associated with the opposite outcome (the so-called Environment Kuznets Curve or EKC (Omri et al., 2015); however, the majority do not.

Numerous studies are now including financial development in order to compensate for the bias caused by missing variables. This is done because it is presumed that financial development has a positive effect on both the level of economic output and the quality of the environment; however, the results of numerous studies have been inconsistent. Theoretically, an increase in economic production (the "wealth effect") brought about by financial development is projected to bring about an increase in the amount of energy consumed and the amount of carbon dioxide emitted. On the other side, economic growth may lead to investments in more sophisticated technology (technical impact), which, in turn, may lead to greater energy consumption (efficiency) and lower CO_2 emissions (Y. J. Zhang, 2011). found that increasing green financing reduces the bank's willingness to issue loans, which in turn lowers the efficiency of renewable energy and has a negative impact on environmental quality (Frankel & Romer, 1999a).

Financial development, according to Dogan & Seker (2016d), potentially result in lower financing costs and enhanced industries such as banking for investment portfolios and their ROI. For instance, (Birdsall & Wheeler, 1993) provide evidence with Latin American case studies to demonstrate that financial openness permits the import of developed country pollution standards and, consequently, more stringent regulation environmental policies that improve environmental quality. In a related investigation, Creane et al. (2004) indicate that FD improves the efficacy of financial transactions and the distribution of resources in a financial climate that fosters rapid technological advancement. Similar to Dasgupta et al. (2001) assert that countries with high FD tend to pollute less because they have more inventive environmental programs for carbon trading (F. Islam et al., 2013). The antecedent arguments suggest that FD aids in reducing the degradation of the environment by decreasing energy consumption through energy efficiency.

It is important to evaluate the environmental impact of FDI in addition to the relevance of a healthy financial sector for the human and financial development of a nation's economy. Indeed, studies on the connection between FD and environmental quality have shown conflicting results. Common methods of gauging FD include the proportion of deposits (bank assets) to GDP, liquid obligations, and domestic lending to the private sector (Shahbaz et al., 2018b). According to the first body of research, FD significantly improves the environment's sustainability by reducing degradation of the environment. For example, Tamazian et al. (2009b) examined the influence of FD on GHGs emissions in BRICS economies. They demonstrated that FD improves environmental quality by reducing GHGs emissions. Similarly, Jalil & Feridun (2011) discovered a correlation among the FD and environmental degradation. Regarding China, Salahuddin & Alam (2015) discovered that FD mitigates carbon emissions. Dogan & Seker (2016d) investigated the correlation among FD and quality of the environment in 23 countries. Using FMOLS and DOLS, they determined that FD promotes environmental quality by preventing environmental deterioration. More research, however, suggest that FD could reduce transaction costs, particularly financing costs, allowing businesses to invest in more equipment, thereby increasing energy consumption and CO_2 emissions (Dogan & Turkekul, 2016).

Assessing the environmental impact of FDI is crucial, as is ensuring a healthy financial sector for the economic and social development of a country. Contradictory results have been found in studies examining the link between FD and environmental quality. Most often, FD is gauged by looking at the proportion of a country's GDP that is held in bank deposits, the size of the country's liquid commitments, and the amount of money lent to the private sector inside its own borders (Ali et al., 2015). It is important to evaluate the environmental impact of FDI in addition to the necessity of a healthy financial sector for the economic and human development of a country. Research on the link between FD and environmental quality has, in fact, shown conflicting results. Typically, FD is gauged by looking at the proportion of deposits (bank assets) to GDP, the level of liquid commitments, and the amount of domestic lending to the private sector Y. J. Zhang (2011) found in a study of the relationship that China's economic growth contributed to environmental degradation. Farhani and Ozturk (2015) report comparable findings from the research they conducted of Tunisia over four decades (1971–2012) using the ARDL method. Boutabba (2014) for Indonesia and India, respectively, provide supplementary evidence for these findings.

The second body of literature demonstrates a correlation among FD and degradation of the environment. For instance, Boutabba (2014) came to conclusion that FD reduces emissions in India. Their data suggest that FD slows down environmental deterioration through raising carbon emissions. Similar to this, Javid & Sharif (2016b) investigated the effects of FD on the environmental quality of Pakistan from 1972 to 2013. Their research shows that FD severely reduces ecological quality. Similarly, by using erratic estimate methods, (Ahmed et al., 2021). They discovered that FD reduces ecological quality. Likewise, by applying erratic estimate approaches, Abbasi & Riaz (2016) found that FD has a favorable effect on Japan's ecological degradation. According to Tamazian et al. (2009b), FD in transition economies has a negative impact on CO_2 emissions. Shahbaz, Tiwari, et al. (2013), using the ARDL method for the years 1965–2008 in South Africa, conclude that economic growth enhances environmental quality. Despite the fact that the EKC had evidence ,Omri et al. (2015) , who used the ARDL method for the South African period of 1965–2008, come to the conclusion that environmental quality is improved by economic expansion. Despite the EKC's supporting evidence. In addition, A. K. Hossain & Hasanuzzaman (2012) According to their analysis of 12 MENA nations from 1990 to

2011, financial development had no discernible or significant impact on CO_2 emissions. Shahbaz et al. (2016) for Pakistan, for the UAE, Baloch et al. (2019) for 59 BRI nations, and Saud et al. (2020) for 49 countries report a positive correlation between FD and environmental degradation.

In contrast, according to the third body of research, FD has little to no effect on environmental quality. For instance, Ozturk & Acaravci (2013) FD's effect on turkey emissions between 1960 and 2007 was examined. They discovered that FD has no appreciable environmental effects. Destek & Sarkodie (2019) additionally found no connection between FD and ecological quality. It is important to evaluate the environmental impact of FDI in addition to the relevance of a healthy financial sector for the economic and social development of a country. Actually, studies examining the connection between FD and environmental quality have shown conflicting results. Deposits (bank assets) as a proportion of GDP, liquid liabilities, and domestic lending to the private sector are the most common ways of gauging FD.

H_1c: There is a correlation between FD and sustainable development.

2.3.4 International Trade and Sustainable Development Nexus

Nations can expand their markets through international commerce and get access to goods and services that may not be offered domestically at the moment (Dabwor et al., 2022).The key forces behind economic progress in the majority of resource-rich countries, including the OPEC members in Africa, have been the favorable benefits of global trade, such as increased production efficiency, use of surplus products, and higher revenue. Markets that are integrated globally are essential for economic growth, and exploitation of natural resources has significant global environmental consequences. (Ajayi & Ogunrinola, 2020). The commercial structure, market, and consumption and production techniques are all significantly impacted by an increase in trade flows, which causes a rise in CO_2 emissions and a reduction in environmental quality. However, the research currently in circulation argues that increasing trade to global markets not only boosts the growth and market share of trading states but also boosts competitiveness between nations and promotes resource use efficiency, improving environmental quality. (Hanif, 2018; Usman et al., 2020). By leveraging cutting-edge technologies, international trade enables the efficient use of energy consumption and the cost-effective implementation of sustainable development laws.

International commerce can promote economic growth, and transfer income activity has a direct bearing on environmental deterioration, according to the research (Cherniwchan et al., 2017). This suggests that the breadth, technique, and compositional factors influencing the environmental deterioration may be significantly influenced by global trade (Bataka, 2021). Maintaining all other factors constant, income increases brought on by trade opportunities may have a favorable impact on the range of economic activity through increased production to meet the demands of newly created markets, which will unavoidably result in more environmental damage. The "exchange scale effect" is another name for trade-induced economic growth (Cole, 2004).

However, economic expansion may promote environmentally friendly industrial techniques and provide funding for government investment in environmental mitigation technology, leading to a cleaner environment (Dinda, 2005). The "trade-induced technology impact," which reveals an inverse relationship between economic growth and environmental degradation,(Cole & Elliott, 2003). Therefore, according to Dinda (2006), International trade is the sole thing that makes the expansion of the PHH possible. Due to the influx of industries that produce a lot of pollution into countries with loose environmental restrictions, commerce thus indirectly contributes to the environmental degradation. Additionally, whenever an economy participates in the global trade system, the composition impact, or change in the relative structure of labor and capital, may result from the unrestrained movement of input factors. According to Antweiler et al., (2001), Unrestricted movement of manufacturing-related components suggests that production takes place in regions with an abundance of resources. Due to increasing exploitation and subsequent production activities brought about by trade openings, there was more environmental damage and pollution (Managi et al., 2009).

Grossman & Krueger (1995) stated that the economic policies in place have an impact on how trade affects the environment. There are two different schools of thinking on how global commerce affects CO_2 emissions. According to the first school of thought, trade liberalization gives every country access to global markets, boosting market share among countries(Shahbaz et al., 2012). This increases international rivalry, enhances the use of limited resources, and promotes the importing of environmentally friendly technologies to lower CO_2 emissions (Runge, 1994). (Helpman, 1998) Another group made the argument that global trade depletes natural resources. This depletion of fossil fuels worsens environmental integrity and raises CO_2 emissions (Chaudhuri & Pfaff, 2002; Schmalensee et al., 1998) In country research, Machado (2000) discovered a link between Brazil's CO_2 emissions and worldwide trade. Mongelli et al. (2006) came to the conclusion that Italy fits the pollution refuge hypothesis. To determine the relationship between Turkey's energy use, CO_2 emissions, and economic growth, (Halicioglu, 2009) more openness to trade. They discovered that increases CO_2 emissions while trade openness is one of the major drivers of economic growth.(S. Chen, 2009) Researchers looked into the issue in Chinese regions and found that the expansion of the manufacturing industry is linked to a rise in CO_2 emissions because of higher energy usage. Nasir & Rehman (2011) employed the cointegration test and the ADF unit root test to support the EKC in Pakistan and found that trade openness had a favorable influence on CO_2 emissions. However, (Shahbaz et al., 2012) trade openness has been shown to reduce CO_2 emissions. Moreover, Tiwari et al. (2013) claimed that the openness of India's trade undermines environmental quality.

First, it is frequently asserted that increased levels of global commerce or trade openness led to environmental degradation (measured by the level of CO_2 emissions) (Ertugrul et al., 2016; Jebli et al., 2016a; Usman et al., 2020). It is believed there is an immediate effect since trade flows require increasing a country's economic capacity, which has negative effects in the form of environmental contamination. Therefore, unless these patterns are effectively mitigated or the development is powered by light energy, which is recognized as green growth, it is not environmentally benign. The consumption of traded commodities in each country can be associated to Greenhouse gas in other countries because of the interrelated nature of the global economy. The impact of commerce on CO_2 emissions, however, varies. Several studies, like this one, have demonstrated the beneficial impact of trade on CO_2 emissions (Ajayi & Ogunrinola, 2020; Copeland & Taylor, 2004; Halicioglu, 2009; Usman et al., 2020). In contrast, studies such as Managi et al. (2009) whereas H. Sun et al. (2019) reported ambiguous results between trading and environmental degradation, discovered strong negative effects of trade flows on CO_2 emissions. It is noteworthy that the disparities in the countries, techniques, time scales, and harmful environmental indicators utilized could account for the variations in the results. International concerning environmental deterioration provide inconsistent empirical outcomes. The impact of global trade on greenhouse gases is examined in this study.

H_1d: International trade has impact on the sustainable development.

2.3.5 Public spending and Sustainable Development

Policymakers around the globe strive to produce environmentally conscious remedies for the degradation of the environment and uncontrolled climate change. Although government spending on R&D is viewed as a significant factor in achieving more sustainable economic growth, technology is the preferred method for achieving green economic growth (Huntington, 2015). This concept promotes innovation and is supported by the majority of economic experts. Prior to implementing a green economy, it is imperative to analyze its determining factors. Changes in public expenditures are a key indicator of green growth (Aly et al., 2017). Existing research indicates that economic as well as environmental degradation directly influence the makeup of public expenditures. The association between the public spending and greener economic growth lacks substantial evidence (Iqbal et al., 2020; Lepitzki & Axsen, 2018). Numerous prior research studies confirm the role of reforming fiscal expenditures as a crucial factor in the development of the green economy. Increasing public spending accelerates economic growth but reduces green economic development by increasing environmental risks. In order to compensate for suboptimal investment, the theories of neoclassical and economic evolution explain the recent rise in public expenditure on environmentally friendly energy options (Facchini & Seghezza, 2018). Public funds can compensate for market failures, leading to the development of innovative technological solutions. Private R&D expenditures are insufficient to produce innovative solutions; therefore, public funding is necessary (M. Wu et al., 2021). Alternatively, based on the theory of evolutionary economics, the basis for the development of appropriate technologies by businesses cannot be immediately established based solely on the accessibility of new technologies developed through public expenditures. This necessitates the participation of private sectors with support from the public sector.

Multiple economies are facing a fiscal crisis because governments are unable to come up with a deficit between the public expenditures and taxes. Due to the consequences of such a crisis, budget cutbacks to a green economy make society miserable (Afonso & Furceri, 2010). The magnitude of public expenditures in the green economy and the connection between the composition of public expenditures and economic growth influence the implementation of fiscal policy. This query is prompted by public expenditure components that have a greater impact on green economy than others (Iram et al., 2021). Changing the level and structure of the total public expenditure on R&D allows a nation to better its economic performance.

Numerous studies have been undertaken on the long-term effects of fiscal policy on various measures of ecological burden. Using annual data to empirically examined the influence of the extent of public expenditures on any one of the ecological indicators, the majority of researchers examined long-term relationships. Lopez & Palacios (2010) conduct a comprehensive literature review on the long-term effects of monetary policy on various aspects of economic development, including its influence on the environment. They find that the favorable influence of fiscal regulation on emissions is limited to certain countries and certain aspects and is not a worldwide phenomenon. G. Halkos & Paizanos (2015) conducted a comprehensive literature review on the connections between the economy and carbon emissions, as well as the connection between fiscal policy and its environmental effects. The majority of panel studies indicate that, on a typical basis, countries that invest more in public expenditures have lower pollution and emission levels. Bernauer & Koubi (2013) examine the connection between the quantity of government expenditures and the quality of the air as an indirect method of determining whether governments become larger to provide better services (including better air quality) or as a result of the influence of special-interest groups. Using panel data from 1971 to 1996, they discovered that larger administrations tend to have been associated with poorer air quality. In a similar vein, G. E. Halkos & Paizanos (2013) examined, using a cohort of 77 countries, both the immediate and distant effects both the immediate and distant effects of government size on pollution, measured by the release of CO_2 and SO_2 per capita. The indirect pathway incorporates the effect of government expenditure on income, followed by the effect of income on emissions. In broad terms, the impact is negative, however in the case of SO_2, it could be positive for countries with high incomes. Adewuyi (2016) study reached the same conclusion. The author used panel data to explicitly examine the relationship between household, firm, and government expenditures on collective and sector carbon emissions in various kinds of economies over the past decade. His findings indicate that, on average, government expenditures tend to increase total carbon emissions, although the temporal composition of this effect is complex. Galinato & Galinato (2016) examined the environmental effects of government size using deforestation due to agricultural land expansion and associated greenhouse gases emissions as a central measure of ecological burden. A theoretical model and empirical findings showed that a rise in total government expenditure leads to an increase in deforestation in developing economies.

There is a growing corpus of evidence indicating that the kind of public expenditures has a significant impact on the environment. Using a panel of 47 countries, López et al. (2011) found that a reallocation of government expenditure regarding social and public services reduces pollution. However, increasing government expenditure without modifying its composition has no effect on the environment. A. M. Islam & López (2015), who conducted a panel investigation of American states, reported similar findings in their paper.

In a similar vein, Lopez & Palacios (2010) It has been shown that boosting the share of government expenditure in the GDP and shifting the focus differ from non-subsidies and toward expenditure on infrastructure goods lower ozone and sulfur dioxide concentrations but not nitrogen oxides. Similar to this, energy taxes lower nitrogen dioxide concentrations but had no impact on ozone of elemental sulfur. In summary, trade openness affects sulfur dioxide directly, but not nitrogen dioxide or ozone. The empirical findings are based on air quality measurements from a significant number of air quality monitoring stations in twelve European nations. As a foundation for their empirical analysis, Galinato & Islam (2017) created a game-theoretic equilibrium framework involving government and taxes in which pollution is a byproduct of consumption. They discovered empirically that pollution, as measured by CO and NO2 concentration, decreases with the proportion of total public expenditures allocated to public benefits. However, this effect is moderated by the degree of democracy: it is more pronounced in more democratic regimes.

Previous research has demonstrated that government spending plays a crucial role in minimizing carbon emissions. For instance, Fiscal spending structure is adversely connected with per capita carbon emissions, but fiscal expenditure magnitude is favorably correlated with CO_2 emissions (F. Wang et al., 2019.). Additionally, the activities of government expenditure and governance raise CO_2 emissions (H. P. Le & Ozturk, 2020). Spending on education can raise people's knowledge of energy saving and emission reduction, which will help to reduce anthropogenic CO_2 emissions (Misra & Verma, 2015); Ecological spending could lessen environmental harm, improve environmental quality, and help reduce greenhouse gas emissions. (Basoglu & Uzar, 2019) Communities with comparable socioeconomic characteristics have varying local public spending carbon footprints. In conclusion, the financial investment has a variety of effects on carbon abatement.

Despite having some impact on CO_2 emissions, carbon trading legislation is insufficient to meet the dual carbon objective (Lo, 2016; Heggelund, 2019). Secondly, government spending is another successful strategy for lowering carbon emissions (Krajewski, 2019Additionally, the impact of municipal state expenditure on cutting emissions in the electrical industry has not been adequately studied. Future studies need to pay more attention to how municipal public spending affects reducing carbon emissions in the electricity sector.

For a country which tries to build a green economy by increasing the rate of employment and income of people it depends on private and public green investments. With those investments comes improvement in the activities of the economy like the infrastructure of green energy in decreasing carbon emissions, enhancing the resource and energy effectiveness and defending ecosystem and biodiversity (Sun et al., 2020). Merely depending on public finance does not yield the results of sustainable development, there is a need for proper green infrastructural projects that can be initiated by the government to enhance the green finance and investments which will lead to sustainable development (Yoshino et al., 2021). Public investments in human resources and green energy technology research and development promote a sustainable and green industry through labor- and innovation production and unique effects on other countries (D. Zhang, Mohsin, Rasheed, et al., 2021). As study suggest the public spending has different effect in different nations so this study is going to investigate this relation on different countries.

H_1e: Public spending and sustainable development are correlated.

2.3.6 Foreign Direct Investment and Sustainable Development Nexus

The connection between FDI and pollution of the environment has long been the subject of debate. The 'pollution haven hypothesis' is the most well-known theory supporting links between FDI and contamination of the environment (Copeland & Taylor, 1994). In accordance with this the hypothesis, multinational corporations relocate pollution-intensive industries to nations with less stringent environmental regulations in order to avoid costly compliance with regulations in their native countries. Consequently, developing nations become "pollution havens" and endure greater environmental pollution. In contrast, the pollution fringe hypothesis M. H. Kim & Adilov (2012) postulates that multinational corporations export their clean technologies to developing/hosting nations. FDI inflows can therefore help to lessen environmental pollution. Grossman & Krueger (1991) argued that it is more challenging to assess the association among both FDI and pollution because of scale, composition, and technique effects. J. He (2006) Scale impact describes an increase in pollution emissions and economic expansion brought on by foreign direct investment. The GDP of the host country can rise as a result of FDI. Pollution emissions will rise if this activity remains the same. The impact of the method may aid in reducing emissions and enhancing environmental quality. Modern, eco-friendly technologies can be transferred by foreign enterprises. Technology transfer increases energy efficiency and lowers pollution. The composition effect could have both favorable and unfavorable effects on the environment (Jalil & Mahmud, 2009). A flood of filthy foreign wealth enters nations with lax environmental rules. The proportion of polluting industries grows as a result of this influx. According to the theory of comparative advantage, industries that need a lot of labor but are less polluting will become more popular if there is a surplus of cheap labor.

Both theoretical justifications and actual evidence refute the notion that FDI and CO_2 emissions are related. The bulk of studies used multi-country analysis, with different outcomes for each country. It may be discovered that FDI has a favorable impact on carbon emissions. Jaworski & Wei (2004) FDI inflows increase CO_2 emissions in host countries, according to research that looked at 24 transition economies in Europe. The ecological haven theory is validated by this research. Pao & Tsai (2011) studied the dynamic links between the FDI, energy consumption, economic growth, and CO_2 emissions in the BRIC countries. These researchers discovered that FDI had a beneficial effect on CO_2 emissions using a panel cointegration approach. By applying a panel model, Al-mulali (2012) discovered that in 12 Middle Eastern countries, Net FDI inflows increased CO_2 emissions over time. Another discovery is the inverse relationship between FDI and CO_2 emissions. For instance, Tamazian et al. (2009b) discovered that the BRIC countries' financial development and higher FDI levels can help cut CO_2 emissions. J. W. Lee (2013) identified a link between FDI and CO_2 emissions in countries of the European Union. Al-Mulali & Tang (2013) discovered that FDI helps the Gulf Cooperation Organization (GCC) countries reduce their greenhouse gas emissions, disproving the pollution haven theory. Mielnik & Goldemberg (2002a) 20 emerging countries were found to have similar results. FDI has little impact on CO_2 emissions, according to the research. Perkins & Neumayer (2009) discovered, for example, that CO_2 effectiveness is unaffected by FDI inflows. In nations with high incomes, Hoffmann et al. (2005) discovered that there was no link between FDI and CO_2 emissions. (Atici, 2012), panel data from 1970 to 2006 were used to draw the conclusion that FDI had no impact on CO_2 emissions. J. W. Lee (2013) used panel data from 19 G20 countries to investigate the contributions of inbound FDI to CO_2 emissions. The findings showed that FDI inflows and CO_2 emissions are not correlated.

Alternatively, single-country investigations have been conducted. By employing data from time series from Malaysia, Hitam & Borhan (2012), C. G. Lee, (2009) discovered that FDI has a significant impact on pollution and that FDI growth will increase CO_2 emissions. Acharyya (2009) discovered that the pollution haven theory is supported by the fact that FDI has a significant positive impact on CO_2 in India. Nonetheless, List & Co (2000) found that investing in the USA resulted in lower CO_2 emissions and higher energy efficiency. Shahbaz, Ozturk, et al. (2013) discovered that FDI leads to the transfer of energy-efficient technology to domestic enterprises, which has a negative impact on Turkey's CO_2 emissions. According to Sbia et al. (2014), UAE energy consumption and CO_2 emissions were reduced with the help of FDI. In Indonesia, (Merican et al., 2007) found comparable results.

China's environmental policy has drawn more attention as a result of a considerable increase in FDI inflows and growing environmental damage. (J. He, 2006) built a concurrent model to look into the connection among FDI inflows and carbon emissions and came to the conclusion that FDI inflows are the root source of industrial emissions. Y.-J. Zhang (2011) claimed that FDI was a factor in China's increasing CO_2 emissions. Cole & Elliott (2003) studied how FDI affected quality of the environment in 112 of China's most populated cities and found that air and water pollution were significantly reduced as a result. This research supports the ecological haven effect. making use of a special cross-city panel data collection, Zheng et al. (2010) studied the connection between wage rates, foreign direct investment, and ambient air pollution. The results showed that FDI lowers air pollution in the cities under study. xuehua & nini (2011) learned that FDI does not focus on industries with high pollution levels, and there is no proof that this strategy increases pollution levels in Shandong province. government objectives, according to K. Zhang (2012), assist with energy savings and decreases in emissions. In order to meet its objective of reducing carbon emissions, the Chinese government is attracting more FDI into energy-saving technologies. (Abdouli & Hammami, 2017, 2020; Shahbaz et al., 2018c; Udemba, 2021; Udemba et al., 2019); have done empirical studies with varying findings about the effects of FDI and their impact on the environment. Specifically, (Blanco et al., 2013; Sapkota & Bastola, 2017; Udemba, 2020) for India FDI was found to have a favourable impact on the environment. However, other study discovered a conflict between FDI and the environment (Al-Mulali & Tang, 2013; Desalegn & Tangl, 2022; M. E. Hossain et al., 2022; Tang et al., 2016; Udemba, 2020). Studies on the link between foreign direct investment and pollution have been conflicted due to regional differences in both economic development and environmental laws. The approaches and designs used in research have also changed. Current studies of a few countries have mostly focused on the global perspective.

H_1f: FDI has impact on Sustainable developments.

2.3.7 Technological Innovation and Sustainable Development

When a technology-based invention is perceived as having a new market or service opportunity, an iterative process of development, production, and marketing is started in an effort to make the idea commercially successful (Garcia & Calantone, 2002). In past studies explore the influence of technological advancement on economic growth. Both the quantity and quality of innovative activity are related to GDP growth, according to a study (Hasan & Tucci, 2010). Another study demonstrates that energy availability is essential for growth and that energy consumption and output are highly correlated. Energy resources used to be a constraint on the output of the economy and economic growth, but this is no longer the case because to increased energy availability, technological advancement, and the use of higher quality fuels. Energy is still crucial, though. In developed and some developing nations, the amount of energy utilized per unit of economic output has decreased as a result of technological advancements and a switch from coal to higher-quality fuels, particularly electricity (Stern et al, 2011).

In the setting of energy sector, the study demonstrates that emerging innovations in the field of renewable energy have been influenced significantly by public policy. First off, the adoption of the Kyoto Protocol has had a beneficial and considerable influence on the activity of patents related to solar energy, as well as patents for RNE in general. Additionally, all models and some models indicate that public spending in R&D has a favorable and considerable impact on technological innovation with regard to wind and solar power as well as geothermic and ocean sources (Johnstone, Haščič, Popp, et al., 2010). Technology and exports have a favorable and considerable impact on the economies of rising Asia. Similar to the short-run estimation, the long-run estimation determines the important and favorable effects of international trade and technology innovation on the countries' economic growth (Sultan-uz-zaman et al., 2019).

According to study by Kihombo et al. (2021), which examined the influence of technological innovation on ECFP in West Asia and the Middle East, ECFP fell as technological innovation grew. Technical advances are crucial for lowering the extent of ECFP, according to research by B. Yang et al. (2021) that analyzed the economies of Brazil, India, China, and South Africa from 1990 to 2016. Technology has a minimal impact on ecological footprints in major emerging market countries, according to research by (Destek & Manga, 2021). Further, Chunling et al. (2021), who studied the impact of patents on the development of ECFP in Pakistan from 1992 to 2018, concluded that technological progress degrades ecological standards. Y. Sun et al. (2022) elaborate on this point by noting that countries with more developed economies, better technology, and more efficient energy use see a bigger influence from innovation. Ahmed et al. (2021) Khattak & Ahmad (2022), Liguo et al. (2022) examined how technologies affect emissions reduction in different locations. It has also been shown to be helpful in the United States (Liguo et al., 2022). Technology improvement mitigates environmental degradation by decreasing carbon emissions in key nuclear consumer countries, according to recent research by (Sadiq et al., 2023). But more research is needed to completely understand how technological development affects the ecological footprint of economically sophisticated nations.

H_2: Technological Innovation mediates the relationship between Green Financial Indicators and Sustainable Development.

2.3.8 NRR and Sustainable Development

Rent from natural resources (NRR) is essential to the growth of most countries. For the development and expansion of their economy, these countries typically rely on the resource exploitation (Xue et al., 2021).The association among natural resource rents and carbon emissions is contentious. Some research indicates that rents for natural resources may have a positive impact on carbon emissions (Ulucak & Ozcan, 2020). The exploration and extraction of the hydrocarbon and various other natural assets of the African continent frequently result in extra consumption of energy and carbon emissions. Moreover, industrialization's economic development has increased consumer demand for the consumption of natural resources (Kwakwa et al., 2020). Environmental deterioration is a result of the following production and consumption. According to additional study, natural resource rentals have a detrimental effect on emissions (Badeeb et al., 2020). For instance, natural resources foster globalization by boosting overseas trade, FDI, and currency exchange. They also raise energy consumption efficiency, which lowers carbon emissions (Sinha & Sengupta, 2019). Additionally, abundant natural resources may lower greenhouse gas emissions by reducing the consumption and imports of fossil fuels (Balsalobre-Lorente et al., 2018). It has been demonstrated that institutions and management have an impact on natural resource rents and greenhouse gas emissions. It has been demonstrated that institutions and management have an impact on NRR and greenhouse gas emissions (Amiri et al., 2019). Tiba et al. (2019) The use of inappropriate technologies by nations with weak infrastructure or regulatory quality has been recognized to increase the ecological footprint. Effective regulation promotes manufacturing in many resource-rich countries. Amiri et al. (2019) imply that improving institutions' standards might help to break the resource curse.

Hassan et al. (2019) claimed that NRR improves environmental protection, which in turn promotes economic growth. When examining the connection between NRR and EVP, S. Huang & Liu (2021) determined that NRR will cause a reduction in the US environment's quality if proper safeguards are not put in place. According to Razzaq et al. (2020), The environment in the United States is getting worse as a result of a lack of NRR. Aside from that Ibrahim & Ajide (2021) discovered that the BRICS economies of Brazil, Russia, India, China, and South Africa contributed to EVP through NRR, financial development, and high-quality regulations. Discovered that the BRICS economies of Brazil, Russia, India, China, and South Africa contributed to EVP through NRR, financial development, and high-quality regulations. (Tufail et al., 2021) They were surprised to learn that NRR reduces contamination of the environment in the ten least recently industrialized countries.

H_3: Natural Resource Rent mediates the relationship between Green Financial Indicators and Sustainable Development

2.3.9 Green Finance (GF) and Renewable Energy Consumption Nexus

The countries should avoid relying on energy production for their usage. They must try to rely on sustainable development and invest on it. And the best tactic to face global warming and ecological problems with the shift from renewable materials to renewable resources (Suchek et al., 2021). There needs to be use of sources of energy which are greener, renewable, or those which are less risky in usage, at the same time making sustainable development in place (Lai et al., 2022). In meanwhile, long lasting, and sustainable green finance is relied upon private organizations willingness to achieve it (H. Li et al., 2020).

Renewable Energy positively influences human resources in terms of green finance. There are a lot of benefits of renewable energy to society like the availability of quality products, enhancing the standards of living among people and providing equal access to renewable energy to all people within society. These are crucial things for the attainment of sustainable development for a country. There are other advantages of Renewable energy use like reduction in the emissions of greenhouse gases, enhancement in age expectancy, and reduction in the expenses of healthcare and other institutes (D Tobin et al, 2022). Renewable Energy helps in providing the access to healthy food, increasing employment, and solving the problems associated with health care. Developing the economy with the help of research and development is the major advantage of making the energy sector effective through green finance (S Taspinar et al., 2019.). The notion that GF encourages investments in technology by companies, for instance (investments in non-fossil innovation), which enhance environmental quality, demonstrates that GFN contributes to the prevention of environmental deterioration (C. Li et al., 2022.)..

Many aspects of green economics are explored in the available literature. The connection between environmentally friendly funding and sustainable energy is one area of study. One of the earliest analyses of the association between green energy suppliers and technology firms can be found in (Sadorsky, 2012). He says that the dynamic precondition correlations between renewable energy businesses and technology firms are stronger than those between oil prices. Investors' interest in energy products has recently increased, leading in transmission and impacts among renewable energy and green finance (Ma et al., 2019). Progress in solar power technology is slowed by a dearth of financing, as noted by (Y. Wang & Zhi, 2016b). This is because the success of green energy sources is linked to the development of funding for these projects. Sustainable funding and green finance systems should also be regulated by governments to ensure that investments in renewable energy are not hampered by the development of the green financial sector (L. He et al., 2019b). Dalia et al. (2021) emphasize the importance of policies shaped by long-term environmental objectives in adapting to free of carbon and environmentally friendly techniques. Green financing, green bonds, and green investments are also mentioned as useful policy tools for achieving sustainability. The research by Taghizadeh-Hesary et al. (2021) highlights the green bond market's facilitative function in maintaining green financing for energy from renewable sources in the Asia and Pacific. According to Ye et al. (2022), Since the epidemic stopped production in several industries, it is seen as both a task and a chance due to the burden it placed on green energy sources. There is a highly substantial association between renewable energy spending in Pakistan and green financing, ecologically beneficial assets, green stocks, and social responsibility reporting. Indirectly affecting green finance is the reality that expenditures in sustainable energy also promote growth, trade freedom, and economic development, according to some sources (Haque, 2021). Kutan et al. (2018) Determine a favourable correlation between the BRICS nations' equity markets and derivatives investments and the use of green energy sources.

Green credit policy is also closely linked to green licenses for high-polluting businesses(Hu et al., 2021). Dogan & Seker (2016c) look into the EU countries that use the most sustainable energy and find a connection between successful home carbon gas decreases and Financial Development. GHGs emissions are reduced because of green funding, as shown by quantile-on-quantile regression modelling (Saeed Meo & Karim, 2022). Zhou, Song, et al. (2020) create a development gauge for green finance that is tied to pollutants like industrial particles, cigarette smoke, solid waste, and carbon dioxide. Green finance, according to their research, has a positive effect on environmental results in 30 Chinese regions with varying rates of economic development. The amount of sulphuric acid and solid garbage produced declines with economic growth but rises with economic efficiency (L. Zhao et al., 2022). Financial growth has also been shown to improve industrial pollution (Yin et al., 2019b) and nitrogen dioxide (Nassani, Aldakhil, Qazi Abro, et al., 2017). Rasoulinezhad & Taghizadeh-Hesary (2022) look into the connections between carbon dioxide pollution and energy economy, as well as the green energy index and green finance in among the top ten countries that promote green finance. Based on their research, green money can be used to pay for renewable energy initiatives while simultaneously cutting carbon dioxide pollution.

A different set of studies has focused on the impact of GF on the advancement of renewable energy implementation in OECD nations. Numerous studies Xiang & Cao (2023), J. Xu et al. (2023) have confirmed that GF plays a positive influence in the development of green energy utilization. According to Razzaq et al. (2020) green finance may increase investment in green initiatives, resulting in a higher rate of green economic growth in OECD nations. (Shang et al., 2023) found that the issuance of green bonds can encourage the use of green energy in the Chinese tourism sector (L. Huang et al., 2022). There is a bidirectional relation between sustainable finance and green advancement, according to an analysis of yearly data for OECD states from 2010 to 2020. Moreover, green finance facilitates investment in environmentally friendly initiatives. Kozol et al. (2022) examined ecological financing in Germany. They concluded that the green finance market is affected by market uncertainty and government backing. Another study (Han & Li, 2022) investigated the features of green bonds in the United States and Europe. Significant findings validated the role of green bonds in augmenting investment returns and reducing market volatility.

According to the studies, no in-depth research has yet been conducted on the influence of GF and sustainable energy on the achievement of carbon neutrality goals in OECD member countries. The issued green bond serves as a measure of GF, while RNE consumption is chosen as an explanatory variable.

H_4a: Green Finance has positive impact Renewable Energy Consumption.

2.3.10 Financial Inclusion and Renewable Energy Consumption Nexus

This study examines the relationship between FI and RNE consumption, focusing on the reliability, affordability, and environmental friendliness of RNE consumption in specific regions. From a production standpoint, micro and small businesses (SMEs) face financing challenges due to their poor credit rating, that reduce R&D investment (J. Yu & Fu, 2021). However, by enhancing financial inclusion, RNE SME's will be able to obtain access to financial support (T. H. Le et al., 2020), which could increase the generation of RNE while decreasing the price of renewable energy production through innovation in RNE technology. In addition, from a consumption standpoint, increased FI will make it possible for residents and small enterprises to acquire renewable energy equipment, including photovoltaic water heaters (Baulch et al., 2018). In addition, the growing supply and declining price of renewable energy are attracting more homeowners and companies to its use. In order for businesses and customers to access credit, insurance, banking services, make purchases, and save money, financial inclusion entails providing them with suitable and affordable services and goods (World Bank)Despite the growing number of studies devoted to the subject in recent years, no widely accepted set calculation model for gauging financial inclusion has yet been developed (Goel et al., 2017). There are typically two dimensions used to measure financial inclusion: availability and use (Tram et al., 2021). The latest research on how access to financial services affects GDP, creativity, employment, poverty, and ecological sustainability (Huang et al., 2021). Only a few studies have been conducted in Ghana and Turkey to examine the connection among economic empowerment and energy scarcity, and they have discovered that greater financial inclusion significantly lowers energy poverty (Koomson et al., 2021). In addition, new research on energy consumption and energy transformation has not taken into account financial inclusion FI.

Positive or adverse impacts of FI and RNE consumption and the environment are theoretically possible. The significance of FI as a predictor of REC has only been explored in a small number of research (Feng et al., 2022; Li et al., 2022). For example, Feng et al. (2022) investigated how monetary participation affected REC in China. Examined the effect of FI on REC in China using the ARDL model and related statistics. Using the ARDL methodology and data from 1995 to 2019, the authors of this research discovered that increasing the number of ATMs and overall insurance increased green energy usage in China. They conclude that REC has the backing of FI. For the same nation but using data from 30 different regions between 2011 and 2018, (Li et al.,2022) analyzed the impact of FI on REC. They used SGMM to determine that FI could stimulate expansion in RE. They discovered that FI has a different and often asymmetrical impact on RE desire from one region to the next. In places where green energy growth is already substantial, the effect is small. They received FI statistics from PUDFII (Guo et al., 2020). Energy economy is positively impacted by FI, RE resources, trade freedom, and industrial production, as was found by Chen et al. (2022) the research revealed that FI had a significant impact on the US energy sector from financial inclusion has favourable impacts because it makes financial goods and services easily accessible and affordable to a large audience, including the entrepreneurial community. As a result, investing in environmentally friendly technologies is made more easier and less expensive. According to IPA (2017), Through making better ecological practices more widely available, more affordable, and more widely adopted, the inclusive financial system can improve the quality of the environment by assisting in the fight against global warming and other environmental pollution. In low-income societies where it is challenging to get resources for investments in environmentally friendly technologies, financial inclusion is especially crucial (IPA 2017). Baloch et al. (2021) The most significant barriers to the implementation of solar microgrids, it was discovered, are financial restriction and limitations, such as a lack of access to money, limited financial assistance from governments, and a lack of banking services. These few examples show how financial goods and services that are accessible and affordable can encourage the adoption of green technologies and renewable energy sources, improving environmental quality by lowering the usage of carbon-intensive energy sources.

On the other side, greater accessibility and availability of financial services may encourage business and industrial activity, which would raise CO_2 emissions and contribute to global warming (Tamazian et al., 2009a). The population's purchasing power increases as a result of increased FI, enabling them to buy energy-intensive electrical products including cars, microwave, conditioners, refrigerators, dryers, and washing machines. Consuming more of these things raises energy demand, which in turn causes CO_2 emissions. (Frankel & Romer, 1999b) postulate that a system of financial inclusion can stimulate economic growth, resulting in an increase in energy demand and CO_2 emissions.

The empirical evidence relating financial inclusion to consumption of renewable energy is inconclusive. This study examines how financial inclusion affects the consumption of renewable energy. We specifically look into whether offering sufficient financial services to all individuals, especially those who are most vulnerable in society, may help the area employ renewable energy sources to reduce greenhouse gas emissions.

H_4b: Financial inclusion is interlinked with Renewable Energy Consumption

2.3.11 Financial Development and Renewable Energy Consumption

One of the most important problems in economics in recent years has been the connection between FD and energy usage. It has been established that burning fossil fuels increases the atmospheric concentration of greenhouse gases. By contrast, with renewable energy, greenhouse gas emissions are decreased. (F. Islam et al., 2013; Mert & Bölük, 2016; Pata & YURTKURAN, 2018). This result is backed both by theories and empirical studies, and it calls for a study of how financial development, which is one of the key factors influencing the demand for environmentally friendly energy, affects the promotion of the use of renewable energy. Therefore, increasing demand for renewable energy sources can support long-term economic growth (Sadorsky, 2011).

According to Sadorsky (2011), FD affects energy consumption in three ways. First, there is the direct impact, which is linked to increased FD and takes place when consumers have easier access to credit and are therefore able to afford to purchase more expensive, energy-intensive products. Increases in FD have a positive impact on businesses when they improve companies' access to capital. When confidence rises with economic growth, it causes a "wealth effect" by driving up energy use. Energy consumption might be negatively impacted by FD (RNE). Foreign direct investment (FDI) may be attracted by FD thanks to the technological impact. That's why companies are more likely to put money into cutting-edge and efficient technology, which in turn reduces ENC (Shahbaz, Van Hoang, et al., 2017). According to Chiu & Lee (2020), In countries with a sound financial system, financial institutions play a crucial role in enabling enterprises to easily obtain finance from banks and stock markets. As a result, businesses looking to invest in cutting-edge, energy-saving technologies would have easier access to funding. RNE would consequently decline.

There are three channels via which FD affects energy use. The first kind of impact is direct, and it's connected to increased FD and comes when consumers have easier and cheaper access to credit, allowing them to purchase more expensive, energy-intensive things. When increased FD makes it feasible for businesses to have greater access to financial resources, a positive commercial impact occurs. The wealth effect occurs when an expanding economy is accompanied by a rise in confidence, which in turn boosts energy consumption. However, FD might have a negative impact on energy use (RNE). Because of the technological pull, it is reasonable to assume that FD may attract FDI. Therefore, companies are more likely to invest in state-of-the-art and energy-saving technology, resulting in a decline in ENC. According to Sadorsky (2010b), FD is favorably and significantly associated with RNE in 22 nations with emerging economies. Similarly, Sadorsky (2011) established that, as assessed by bank variables like the ratio of financial institution deposits to GDP and the ratio of deposit money bank assets to GDP, FD has a favorable effect on ENC in nine bordering Eastern and Central European nations. According to a study using information from 29 Chinese provinces, FD encourages ENC when loans to financial firms is added to GDP and FDI is utilized as FD indicators (Xu, et al, 2012). In contrast, Ouyang & Li (2018) discovered that FD lowers energy consumption in 30 Chinese provinces as measured by inventory turnover, lending, and money aggregate M2. with the aid of dynamic panel from 27 EU nations, Sadorsky (2011) showed that, regardless of the cause of FD, FD is strongly linked with ENC in older individuals (equity markets or institutions). The method used to calculate FD determines if there is an association between it and ENC in new members. Similarly, Aslan et al. (2014) discovered that, over the long term, for seven Middle Eastern countries, the growth of the banking industry is positively connected with ENC. In addition, Chang (2015) By dividing the data from 53 nations into two subsamples based on income level—high-income regimes and low-income regimes—it was shown that, when assessed by banking sector indicators, foreign direct investment rises under low-income regimes. Stock market indicators imply that ENC somewhat declines in developed countries. Some studies that focused solely on a specific FD measure and a single nation produced conflicting conclusions. With regard to Japan, Rafindadi & Ozturk (2016) found that FD as measured by domestic lending to private enterprises affects electricity usage in a favorable and significant way. the identical FD indication, Shahbaz, Van Hoang, et al. (2017) discovered that FD lowers India's energy use. Using the same FD metric, Farhani & Ozturk (2015) reached the similar conclusion for the United States. Nevertheless, they found that FD raises short-term energy demand while lowering long-term ENC.

Many studies have looked at how FD affects the use of conventional energy, but few have particularly focused on renewable energy. Regarding 22 underdeveloped countries(L. Wu & Broadstock, 2015), It was found that the adoption of renewable energy is positively impacted by extended its influence and financial growth. Burako & feridin et al. (2017) found no link between FD for Russia (as measured by bank loans as a proportion of GDP) and RNE. Using panel information for 137 countries (R. Best, 2017), The argument that financial investment helps the shift to a capital-intensive source of energy was supported by a number of FD indicators. His empirical research also showed that high levels of financial resources make it easier for high-income countries to switch from sources of energy based on fossil fuels to contemporary renewable energy sources (particularly wind). More funding for wind energy comes from institutional private credit and domestic private debt securities. Similarly, Ji & Zhang (2019b) examined information from 1990 to 2014 about the Chinese stock market. According to their research, FD is crucial and is responsible for about 42% of the variation in the proportion of renewable energy. In addition, Anton & Nucu (2020) studied how FD affected RNE across 28 countries in the European Union (EU). The panel data analysis with a fixed effect showed that FD has a favorable impact on RNE. In addition, they found that RNE in the new EU members is barely impacted by the growth of the capital markets. Using a substantially altered OLS methodology, Shahbaz et al. (2021) studied the connection between FD and RNE in 34 developing countries. The findings showed that FD, measured as domestic credit from the banking industry and domestic credit to the private sector, had a favorable impact on the demand for renewable energy. An analysis of causality using the Fourier-wavelet quantile Pata et al. (2022) assessed how six market and financial institution indicators affected the use of renewable energy in the US. According to a study that used data from 1980 to 2019, access and the breadth of financial markets were discovered to be the most important elements in boosting the use of renewable energy. Habiba & Xinbang (2023) discover that all three aspects of financial development (financial development as a whole, financial markets-related expansion, and financial institutions-related development) have a positive impact on renewable energy consumption.

This study looks at how the use of renewable energy has changed in 66 countries between 2004 and 2019. Based on the accessibility of the data, the variables used in the analysis are selected. The percentage of overall ultimate energy consumption that is used for the use of renewable energy (RNE). Domestic credit obtained from financial sector and domestic credit provided by entities to the private sector are indicators of FD. To create natural-log form, all variables are transformed.

H_4c: There is a correlation between FD and Renewable Energy Consumption.

2.3.12 International Trade and Renewable Energy Nexus

How is the penetration of renewable determined? For possible climate change and difficulties with energy sustainability, the answer to this question is essential. A lot of publications claim (Gozgor et al., 2020; Omri et al., 2015), The key component of energy sustainability will be the demand for renewable power. The penetration of renewable will soon considerably expand because it is a clean energy source (Gozgor, 2016). Therefore, reducing greenhouse gas emissions and delaying the effects of global warming can be accomplished by expanding the usage of renewable energy. Regarding how to deal with the emergency of climate change, this topic will have political ramifications. Currently, one of the main factors affecting energy use and environmental deterioration is international trade (Copeland & Taylor, 2004). According the "Pollution Haven Hypothesis (PHH)," industrialized countries have strict restrictions that control industrial production, which significantly degrades the environment. As a result, a lot of businesses in wealthy countries move their production facilities to developing countries where there are less restrictive environmental restrictions for the manufacturing process (Cherniwchan et al., 2017; Copeland & Taylor, 2004; Eskeland & Harrison, 2003; Gozgor, 2016). According to the PHH, developing countries can boost their output, but environmental issues will be less of a priority because of fewer restrictions. The key policy implication for encouraging international commerce and FDI will be government liberalization of the corporate environment since developing economies are in a race to the bottom.

Additionally, importing new goods through international trade is crucial for maintaining the high level of technology needed for renewable sources. Domestic businesses have a significant chance to change their production plant to be more ecologically responsible thanks to international trade. Trade is usually thought to have an impact on how much energy is consumed. An increase in the use of energy resources may be correlated with an increase in global energy consumption in terms of the intensifying global trade (Dingru et al., 2023). According to Han & Li (2022), the Energy Information Administration (EIA) discovered that the 75% rise in greenhouse gases between 1980 and 2012 was caused by foreign trade. Developed countries often try to limit the use of fossil fuels as a source of energy. Therefore, increasing the consumption and expenditure of energy from renewable sources will be a key tool in policymaking.

They Han & Li (2022) found this after analyzing the connection between higher trade openness, degree of urbanization, and nonrenewable energy consumption. Their study focused on case studies from 1990 to 2018 that were taken from China. The study shows that trade considerably raises China's exhaustible energy usage at all data points of the sample distribution using the quantile regression method. Numerous other research has supported this correlation between rising commerce and rising energy usage. For example, in the research of Parsa & Sajjadi (2017) for the Iranian economy and (Hdom & Fuinhas, 2020) for the Brazilian economy.

Despite the fact that the positive argument predominates in the literature, Han & Li (2022) show that commerce may not have a significant impact on the rate of an economy's usage of renewable energy. It is also possible to assess the impact of trade openness on sustainable power from the perspective of how it will affect carbon emissions. The majority of recent research in this area yields contradictory findings. Between commerce and the use of clean energy, some research showed a positive association, some a negative one, and the rest a negligible one. Regarding some European economies, Alola et al. (2019) came to the conclusion that, in the short run, there is no clear relationship between trade openness and consumption of renewable energy, and that these factors have no bearing on carbon emissions. However, over the long term, they found that openness dramatically lowers pollution levels and promotes the use of renewable energy.

In contrast, Antweiler et al. (2001) discovered that trade openness significantly lowers greenhouse gas emissions, which led to the conclusion that trade may have encouraged the use of renewable energy. This finding was made using data from a sample of 108 cities selected to represent a total of 43 nations between 1971 and 1996. Suri & Chapman, (1998), who examined the relationship between trade and renewable energy in 33 nations between 1971 and 1996 also look into how trade openness affects the use of renewable energy. The research suggests that international commerce may help a country reduce carbon emissions by increasing the likelihood of supporting the use of renewable energy, according to the GLS regression. Their finding is comparable to that of (Akbar et al., 2021), They came to the conclusion that commercial operations enhance both the utilization of renewable and nonrenewable energy.

In addition, Destek & Sinha (2020) Using a case study global trade between 1980 and 2014, show the beneficial impact of global trade liberalization on renewable energy for 24 OECD nations over the period of 1980 to 2014. The empirical findings of Bayar et al. (2020) further supported their conclusive finding of a connection. The latter study examined the relationship between globalization in commerce, finance, and renewable energy and connected it to the level of carbon emissions in certain European countries between 1995 and 2015. Ultimately, their analysis showed a causal one-way relationship between trade performance and renewable energy consumption in EU countries. Additionally, in Croatia and Lithuania, a one-way causal association between renewable energy and levels of energy use was found. According to the research conducted by (Kirikkaleli & Adebayo, 2021), In the near future, Turkey's willingness to engage in international trade and its use of renewable energy are positively correlated.

However, a number of research on the opposing side of the trade-renewable energy dispute demonstrate that trade openness does not support sustainable energy. Regarding the BRICS nations, (Aydin & Turan, 2020) By lowering environmental quality in China and India, trade openness has a detrimental effect on the environment, according to statistics spanning the years 1996 to 2016. Consequently, a conclusion was reached regarding how international commerce affects renewable energy on the presumption that it increases the consumption of fossil fuels. T.-H. Le et al. (2016), demonstrating that the growth in trade openness also raises carbon emissions by lowering the usage of renewable energy, examines 98 nations at varied levels during the years 1980–2013. Additionally, they contend that low-income countries are more negatively impacted by trade than high-income countries are. In the case of emerging economies, Zafar et al. (2019b) indicates that there is a two-way impact of global trade on carbon emissions, suggesting that there should be a two-way impact of trade on renewable energy. In order to address the prospects for environmental sustainability in particular regions, this study has produced a summary of the impacts of foreign trade on the utilization of solar energy consumption in a number of different countries.

H_4d: International Trade has impact on the Renewable Energy Consumption.

2.3.13 Public spending and Renewable Energy Consumption

R&D may influence energy consumption in a several ways or by a many routes. On the one hand, research and development may help reduce energy consumption by fostering new concepts for energy retention (Charfeddine & Kahia, 2019). The theory of endogenous growth claims that expenditure on research and development could result in technological advancements or innovations that improve energy efficiency. Consequently, research and development expenditures tend to reduce reliance on NRR by enabling more TI with fewer greenhouse gases as byproducts (Ankrah & Lin, 2020; Caglayan et al., 2021). In contrast, R&D may increase the use of energy as a consequence of increased output due to openness to export and economic growth. Economic systems where innovation and R&D yield diminishing marginal returns are more prone to this. As the corpus of knowledge expands, it becomes more difficult to make new discoveries, resulting in lower returns on R&D investments (X. Yang et al., 2022). The impact of R&D upon energy usage is even more ambiguous when broken down into pure and filthy components.

From the prior review of the studies, it is clear that several factors have been considered in order to evaluate environmental performance. However, only a little number of studies have examined the link among public expenditures and renewable energy. (Loiter & Norberg-Bohm, 1999) examined the effects of government intervention in the United States wind energy industry. In order to avoid wasting public funds, the authors argue that demand-side policies must be implemented to promote innovation and a more permeable distribution of wind energy. (Ragwitz & Miola, 2005) discover a positive correlation between public investment in R&D, and implementation (RD&D) for RNE sources and investment from the private sector in the same spectrum of RD&D. However, in some nations, such as Denmark and the Netherlands, government involvement is more effective than private market stimulation. The public agent may also implicitly finance private renewable energy investments. For instance, Barradale (2010) examines the influence of tax credits on RNE investments in the United States. The author concludes that the inconsistent execution of the policy over the years has contributed to the volatility of the private market. Johnstone, Haščič, & Popp (2010) examine the effects of RNE patents in a representative sample of OECD countries from 1978 to 2003. The findings indicate that subsequent to the Kyoto protocol, policy decisions and public spending on research and development have had a significant impact on technological innovation, especially in solar and wind energy.

In accordance to the studies, CO_2 emissions could be reduced by investing public spending in R&D and improving the performance of current technology. Given that numerous environmental laws enacted Energy consumption is commonly a target to combat climate change, it is essential to understand the total and separated R&D's impact on electricity consumption(Aydoğan et al., 2020). Researchers and policymakers may improve their predictions about the future consumption patterns by better understanding the impacts of innovation on the energy mix. In keeping with the previous point, our study is in line with the literature on the effects of R&D and funding for R&D on the renewables industry, or the literature on the relationship between energy technology advancements and renewable energy consumption (L. Liu et al., 2020; Saadaoui, 2022; Sugimoto, 2021; Vujanović et al., 2021). Our research focuses on the impact of Public spending (R&D) on RNE consumption, which is beyond the scope of the aforementioned studies. Only Khan et al. (2021.) have examined how emerging technology, as evaluated by patent data from 13 US companies, impacts energy consumption in a manner comparable to ours. According to (Waheed et al., 2019), one-third of all variations in energy consumption are attributable to induced innovation. We contribute to the existing corpus of knowledge by tracking the evolution of R&D and energy consumption in a sample of OECD nations over time. We employ a more accurate statistic by concentrating on R&D spending on alternative energy sources by agencies at the national and subnational levels, as well as state-owned firms, as opposed to using patents as a substitute for development and research. Therefore, our data set covers shifts in energy-related spending over the past ten years and how they have affected nations perceived as leaders in the clean energy sector.

H_4f: FDI has impact on Renewable Energy Consumption

2.3.14 Foreign Direct Investment FDI and Renewable energy consumption nexus

Recent study has started to look into sustainable energy funding sources in light of the significance of applications for renewable energy. In this regard, two ground-breaking studies carried out by (Paramati et al., 2016, 2017). The first study Paramati et al. (2016) examined how the value of stock markets and FDI inflows affected the use of renewable energy in a sample of 20 developing market economies. The authors come to the conclusion that encouraging the use of renewable energy requires both Flow of FDI and the scale of the stock market. Similarly, the second study Paramati et al. (2017) studied how stock market expansion and FDI inflows affected the adoption of renewable energy in the economies of the EU, G20, and OECD. Overall, their findings show that the stock market and FDI both significantly contribute to the promotion of the use of renewable power in these economies. The scientists added that a crucial factor in lowering CO_2 emissions is worldwide political collaboration. These studies, however, don't look at how renewable energy projects are affected by FDI and stock market expansion. This encourages us to do empirical research on the effects of FDI inflows and the expansion of stock markets on the use of renewable energy in developing market economies that make significant investments in renewable energy.

While a large body of research has been written about the connection between economic growth and energy demand, less has been investigated about how FDI affects energy demand. While a large body of research has been written about the connection between economic growth and energy demand, less has been written about how FDI affects energy demand. Mielnik & Goldemberg (2002b) found a link between FDI and energy intensity in 20 developing countries. Sadorsky (2010c) found a substantial and favourable correlation between FDI and energy usage in 22 emerging economies. With the help of FDI, firms can acquire cash more affordably and/or more easily. This capital can then be utilised to grow already-existing activities or to establish new plants and manufacturing facilities, all of which raise the need for energy. The idea that FDI promotes stronger economic growth is compatible with the likelihood that increases in FDI will have a favourable impact on energy demand. If FDI has an impact on energy demand, this relationship may have an impact on energy policy and measures for reducing greenhouse gas emissions.

Additionally, the rapidly urbanizing and industrializing G20 countries will keep growing, which could inescapably lead to a significant rise in CO_2 emissions. Furthermore, FDI may also be a factor; a country's CO_2 emissions may not necessarily depend solely on its degree of affluence. When countries use FDI to boost their economic growth, this could result in a rise in CO_2 emissions. There is ample proof that FDI significantly affects CO_2 emissions. Y. J. Zhang (2011) proven that China's rising CO_2 emissions are significantly influenced by FDI. According to Xing & Kolstad (2002), The amount of FDI and the host countries' pollution emissions are related.

However, List & Co (2000) reported that FDI aids in encouraging energy efficiency and lowering CO_2 emissions in host nations. According to Tamazian et al. (2009c), FDI helps companies embrace new technology and foster technical innovation, which improves energy efficiency and fosters low-carbon economic growth. According to Sadorsky (2009), Consumption of renewable energy is inversely correlated with income. In conclusion, further empirical study is needed to clarify the relationship between FDI, energy consumption, renewable energy utilisation, and CO_2 emissions.

The effect of FDI inflows and stock market expansion on the utilisation of renewable energy has also been studied recently. For example, Paramati et al. (2016) revealed that a sample of 20 developing market economies' use of renewable energy is significantly positively impacted by FDI inflows and stock market capitalization. Similarly, Paramati et al. (2017) examined the effect of stock market growth and FDI inflows on use of sustainable power in the economies of the EU, G20, and OECD. The empirical results of their study show that the utilization of renewable energy is encouraged by FDI inflows and stock market expansion. In order to prevent the rise in CO_2 emissions and to secure technological and financial support, the authors also contend that political cooperation between states is crucial. Recent research by Paramati et al. (2017) studied how FDI inflows and stock market growth affected a group of G20 countries' CO_2 emissions. The research is based on annual time series data from 1991 to 2012 using a range of panel economics techniques. Their findings confirm that, in developed and developing countries, respectively, the expansion of stock markets and FDI inflows cut CO_2 emissions. The authors claim that the stock market development in poor countries has not yet advanced to the stage where it can successfully lessen its detrimental effects on the environment. According to the body of research, no study has looked at how the rise of stock markets and FDI inflows have affected the use of renewable energy in significant emerging market nations.

The influence of FDI on the development of RE has not been investigated in depth. In the few studies that have examined the relationship between FDI and RE, (Kutan et al., 2018) an important beneficial outcome is observed. According to Kutan et al. (2018), FDI plays a crucial role in promoting the growth of RE consumption. These findings indicate that nations with limited financial resources may utilize funds from international investors to promote RE. In addition to encouraging the use of renewable energy, FDI has a negative influence on carbon emissions (Bhujabal et al., 2021). Therefore, promoting FDI inflows among developing nations is crucial. Important is the connection between indicators of the economy and RE. New studies that incorporate multiple indicators into their models should be conducted to determine the most effective means of enhancing RE projects, as stipulated in (Mukhtarov et al., 2022). Important roles are played by macroeconomic factors in advancing RE development. Oil prices (Mukhtarov, 2021; Mukhtarov, Mikayilov, et al., 2020; Sadorsky, 2009) and CPI (Deka & Dube, 2021; Mukhtarov, Humbatova, et al., 2020; Mukhtarov, Mikayilov, et al., 2020) have a negative influence on RE consumption. These findings indicate that excessive energy prices inhibit RE development. Consequently, prices for energy must be stabilized via government subsidies or other means. However, other research such as (Shahbaz et al., 2021) indicates that consumer prices have no statistically significant effect on RE. Therefore, additional research is required in numerous additional areas to determine the relationship between real estate and the consumer price index.

H_4e: Public Spending and Renewable Energy Consumption. are correlated.

2.3.15 Technological Innovation and Renewable Energy Consumption

Technological advancement is essential for fostering the development of clean energy sources and has a significant impact on a country's economy (W. Chen & Lei, 2018). The amount of innovation is primarily influenced by research and development (R&D) expenses and the societal accumulation of information about renewable energy sources. Currently, there are two ways to gauge technical advancement: output of research and development (B. Xu & Lin, 2018). RETI requires a "financial institution" or "business" financial model at different stages in the development of its financial infrastructure (Zhu, 2015). The economy of the nation may conserve energy and cut emissions if the current financial model meets market demand; however, if it does not, financial development will impede RETI, increasing the gdp and pollutant emissions (F. Shen et al., 2021). Development in renewable energy is required for the filing of patents and costs money. During this time, the banking industry has demonstrated its effectiveness as a source of finance for RETI due to its cheap transaction costs (Köksal et al., 2021; Ramzan et al., 2022). Whenever the commercial scale is small and environmental restrictions are minimal, RETI is drawn from foreign technology and is characterized by low market risk, affordable capital requirements, and a quick return cycle (Cornell, 2021; Dutta et al., 2021). Capital becomes increasingly plentiful as the economy grows; as a result, digital banking provides a tremendous service for supplying matching funds and energizing investment, so making funds available for RETI. For the banking sector to perform its role as a middleman between lenders and borrowers, credit and risk management is vita (Williams, 2021). Digital currencies can evaluate consumer credit and risk using big data technology, minimizing the knowledge asymmetry between financial institutions and customers (Rau et al., 2021). Investor awareness of RETI increased because it was recognized as an elevated, high-reward investment (Lv et al., 2021). In order to create a reliable financial reporting system, DF may also obtain and combine behavioral data from many economic challenges (Cao et al., 2021). This makes it easier for customers to decide on RETI investments after doing their due diligence. As a result, RETI is easier to reach for investors, allowing it to quickly end its financial deadlock.

H_5: Technological Innovation mediates the relationship between Green Financial Indicators and Renewable Energy Consumption.

H_6: Natural Resource Rent mediates the relationship between Green Financial Indicators and Renewable Energy Consumption.

2.4 Control Variables

This section of the study reviews the research on the mediating and controlling factors that affect how the correlation values relate to one another. This review will look at the literature on the effects of control variables, mediating variables, and natural resource rent on the link between predictor factors and the outcomes of sustainable development and the use of renewable energy sources.

2.4.1 Urbanization and Sustainable development

Migration of people from rural to urban areas is a sociological phenomenon known as urbanization. Urbanization rises as a result of the economy's expansion. Numerous studies have shown that rising urban populations also result in rising GHG emissions (M. S. Hossain, 2011; K. Li & Lin, 2015; Y. Wang et al., n.d., 2016; C. Zhang & Zhou, 2016). Thus, the scale effect is present when there is a sharp increase in energy consumption in urban areas and a rise in GHG emissions as a result of urbanization. This is also the case when there is a rapid expansion of private transportation, extensive development of public infrastructure (such as roads, sanitation and stormwater runoff), and intensification of urban economic activities. Both positive and negative effects on the environment might result from the urbanization by composition effect. When a sizable section of the work force moves from primary rural to urban industrial sectors, urbanization has a negative effect on the environment. Consequently, the growth of the industrial sector is a factor in the increase in greenhouse gas emissions. On the other hand, when the population of cities grows, services become more readily available to people and the fraction of the economy devoted to the service sector rises, which changes the economic structure and lowers GHG emissions. The technique effect, which happens when an increase in urbanization leads to a more effective and efficient use of urban infrastructure and industrial agglomeration, has a negative impact on GHG emissions, is the last channel of the urbanization effect on GHG emissions. Therefore,(Shafiei & Salim, 2014) confirmed the existence of a Kuznets curve between GHG emissions and urbanization, indicating that environmental effect diminishes with increasing urbanization. Azam & Khan (2016) revealed a strong inverse link between the rate of urbanization and GHG emissions.

Considering research from international panels, Kais & Sami (2016) and Saidi & Hammami (2015) discovered that the effects of urbanization on global GHG emissions are negative and statistically significant. Omri et al. (2015) discovered that the number of urban residents had a detrimental impact on greenhouse gas emissions. In the meantime, Al-Mulali et al. (2012) revealed that across eight provinces, 84% of nations exhibit a long-term link that is favorable between urbanization and GHG emissions, whereas 16% of countries show mixed findings and low-income countries do not. Numerous academics are still examining the significant topic of the URB mechanism's impact on EVP (S. Zhang et al., 2021). For instance, Odugbesan & Rjoub (2020) established in a case study that URB increases commercial and home energy demand, leading to trade structure that are more technically oriented, as industry planners move from rural centers to factories. This point of view contends that URB's effects, coupled with economic advancement and development, have increased energy demand and CO_2 emissions, the acknowledged main contributor to environmental deterioration. Fan et al. (2019) discovered that URB and EGC have an impact on a country's social progress and EVP during a period of transition. Their findings also demonstrated how intricate the connection among URB and environment protection is. Even if a nation's financial situation improves, urban sprawl and economic growth could have a negative impact on the environment. Musah et al. (2021) examined the connections among URB-EVP in West African nations. According to their research, URB has a direct and advantageous impact on EVP.

2.4.2 Economic Growth and Sustainable Development

Kuznet, (1955) initially characterized the connection between economic growth and national inequality using the EKC hypothesis. Since its conception thirty years ago, the EKC hypothesis has been expanded to include the environment, giving rise to the environmental EKC hypothesis. The relationship between economic growth and environmental deterioration is described by the environmental Kuznets hypothesis. There is a claim that there is a threshold between income and environmental harm. Pollution increases as income increases before to the threshold. An rise in income causes environmental pollution to decline after it reaches a particular threshold. Academic research has shown that the initial expansion brought about structural changes and an increase in energy demand, which in turn caused environmental degradation. However, growth brings about technological advancement. These technical developments can encourage green ideas and institutional initiatives, which will enhance the environment (Dinda, 2005).

However, empirical studies on the connection between economic growth and CO_2 emissions have not produced reliable findings. The initial inquiry was carried out by in 1991 (Grossman & Krueger, 1991). Numerous related studies have since been carried out at the national, regional, and international levels both for developed and developing countries. For instance, in Saudi Arabia, the amount of carbon emissions per person rises in direct proportion to the amount of per capita income, demonstrating a monotonically rising link between the two variables (Alkhathlan & Javid, 2013). In both Europe and Asia, Balado-Naves et al. (2018) discovered evidence of a link between income and greenhouse gases that is formed like an inverted U. On the other hand, they found that income and carbon emissions increased monotonically in Oceania. Evidence from 113 countries reveals that the Ekc is inconsistent the with association among economic growth and carbon emissions in a study using GDP and global emissions as surrogacy for economic and emissions. The connection between the two is steadily improving (Luzzati et al., 2018). The empirical analysis of Sadik-Zada & Gatto (2021) disputes the inverted U-shaped relationship between emissions and revenue for each of the 38 oil-producing countries, presenting a weakly monotonic growing relationship instead. In some cases, even the EKC hypothesis is false. Nonlinear parametric methods were employed in the study for Canada, and the outcomes showed that carbon emissions are independent of GDP and connected to population and technology (J. He & Richard, 2010). As the EKC theory was further investigated, an N-shaped association was gradually found. Moutinho et al. (2017) Utilize the cubic polynomial nonlinear specifications to investigate the link between economic growth and environmental variables. According to the evidence, Portugal possesses an EKC of type N. Carbon emissions first increase as industry income increases, but after a certain threshold is reached, they start to decline, according to an N-shaped connection. Then, as the industry's output kept growing, carbon emissions started to soar. This result implies that greater industry-level action is needed to support increased energy efficiency improvements and the usage of renewable energy (R. Li et al., 2022). Additionally, using data from Pacific Island nations between 1990 and 2019, this study furthers the EKC hypothesis by examining the continuous link between investment complexity and carbon emissions. The empirical evidence shows that economic intricacy and carbon emissions have an N-shaped relationship.

2.4.3 Industrialization and Sustainable Development

The EKC hypothesis often sees industrialization as the cause of rising pollution (K. Li & Lin, 2015; Lin et al., 2015; Özbuğday & Erbas, 2015). The differences in industry share are caused by the composition effect, which may have a positive or negative impact on GHG emissions. Tian et al. (2014) discovered that the shift from agricultural, mining, and light industrial production to source of energy factory output resulted in a significant increase in greenhouse gases. In contrast, Naudé (2011) hypothesized that industrialization may help with labor migration from agriculture to industry, hence lowering ghgs from forestry and unsustainable agricultural practices. Additionally, a fall in the industry's share could be seen as a result of the change in economic structure. So, as manufacturing transitions from light industry (agricultural or textiles) to heavy industry (minerals, chemicals, machinery, etc.), pollution is initially produced, but eventually switches to less polluting information-based businesses and services. (Kaikai & Zervas, 2013).

As a result, there are many different empirical conclusions about how industrialization affects greenhouse gas emissions. Degand (2011), Y. Li & Xia, (2013), Özbuğday & Erbas, (2015) and Zhou et al. (2013) concluded that one of the most important variables impacting GHG emissions was industrialization. (Özbuğday & Erbas, 2015) In Tunis, Iran, Australia, Canada, Germany, and Sweden, industrialization has been observed to have significant positive and substantial effect on GHG emissions, whereas in South Africa, Norway, and Turkey, it has had a negative impact K. Li & Lin (2015) discovered that industrialization had a minimal impact on Gas (ghg) emissions in the middle-high income group but raises emissions in low- and middle-income countries.

Numerous research on the relationship among industrialization and sustainability have been undertaken recently. According to X. Sun et al. (2020), On eco-efficiency, the ratio of the industrial structure has a considerable impact. According to this perspective, an industry with a lot of auxiliary sectors is more likely to be utilizing more resources, which reduces environmental efficiency. According to an empirical study by Bahizire et al. (2022), It is thought that a piece of this industrial structure will inevitably affect how well the environment performs. The results of the experiments by Song et al. (2018) and Q. Qin et al. (2020) agree with those from earlier studies.

Alternately, Anser et al. (2020) Examine the reasons for the majority of firms' excessive energy use and emissions. They find that the inclusion or exclusion of undesired output has a considerable impact on efficiency levels after using the DDF model to evaluate data from 21 nations. Cariola et al. (2021) discovered that rapid industrialization generates an inefficient environment, leading to a number of environmental issues such the depletion of energy supplies, pollution, and environmental degradation (An et al., 2020; Goli, 2020). According to (S. He, 2019), different industries have different effects on the environment. The factor endowment hypothesis was put forth by them. According to the study, industries that rely heavily on energy produce noticeably greater pollutants than other sectors, which implies that an increase in revenue in such industries will cause noticeably more pollutants than in other areas. (Shi et al., 2022) believe that while actively pursuing technical innovation and industrial reorganization to address the environmental challenge while expanding the economy is a wise course of action, environmental conservation is crucial.

2.4.4 Trade Openness and Sustainable Development

Trade openness also contributes to the growth-emissions problem. Salman et al. (2019) disaggregated commerce into export and import and discovered that in several Asian nations, export actually increases CO_2 emissions. Scale, composition, and methodology are broken down to examine the impact of trade Openness (Farhani et al., 2014). The scale effect shows that increases in trade volume led to higher levels of production, energy use, and CO_2 emissions. Composition is the process by which commodities or resources that have been exchanged are redistributed. As a result of the technique effect, trade openness typically results in a more environmentally friendly industrial process, one that makes better use of energy and technical innovation.

There are two channels through which freer trade can affect the natural world. The pollution haven hypothesis (PHH) proposes that CO_2 emissions will increase when polluting industries relocate to areas with fewer environmental protections. The top five developing country emitters, which includes China, all contain PHH, according to (Sarkodie & Strezov, 2019). When looking at the impact of FDI on pollution in several Chinese cities, Q. Liu et al. (2018) confirm PHH there as well. M. Zhang et al. (2019) found that China is a pollution host for 22 developed countries and a pollution sink for 19 developing countries. Environmental quality is improved, however, when the host country reaps the benefits of trade-related knowledge spillovers that are beneficial to the environment. The pollution halo effect describes this phenomenon (M. Zhang et al., 2019). By analyzing the effect of trade on CO_2 emissions in 52 industrialized and non-industrialized countries between 1991 and 2014, Essandoh et al. (2020) show that trade reduces CO_2 emissions in developed economies. The research found that countries' emissions went down because of the sharing of knowledge through trade. When countries improve their ability to absorb this spillover by investments in human capital and other ways, they will be able to reap its full benefits.

Researchers pay a lot of attention to how Trade openness affect renewable energy. In Iran, for exampleYazdi & Mastorakis (2014), can verify direct causation between Trade openness and REN. Bidirectional causality between trade openness and renewable energy in India and Brazil was discovered (Sebri & Ben-Salha, 2014). Both Akar (2016) and Jebli et al. (2016b) corroborate the existence of the feedback hypothesis and find a positive correlation between the two sets of nations. The link between Trade openness and REN was found to be unidirectional in the United States (Shahbaz, Solarin, et al., 2017). Similarly, Zeren & Akkuş (2020) discovered that Trade openness led to REN and that RNE led to Trade openness. For low-income economies, Murshed (2020) finds similar outcomes. Several developed and emerging countries have had their REN increase as a result of financial development and Trade openness, as confirmed by (Qamruzzaman & Jianguo, 2020).

On the other hand, Trade openness was found to negatively impact REN, while income and financial growth positively impacted REN in China (P. Zhao et al., 2020). The low price of coal draws investment in energy-intensive manufacturing, which is why trade openness impacts low-income nations.

2.4.5 Population Growth and Sustainable Development

The world's ability to sustain its economy is threatened by the strain that a rising population places on infrastructure and the need for more production. Given the increased acceptance of population expansion and associated expectations of rising consumption, the worldwide ecological overflow seems unavoidable. By 2050, population growth will demand a 2.6% share of global capital be allocated to the environment, a figure that is unachievable (Galli, 2015). The term "global overshoot" describes when the demands for energy by the population exceeds the ecological carrying capacity of the earth. Natural infrastructure, environmental effectiveness, and carrying capacity are all negatively impacted by population growth (Freedman, 2014). Interestingly (Monfreda et al., 2004), Populations are larger in economies with low per capita values than in countries with high values. In contrast, Toth & Szigeti (2016) established that the consumption patterns of the population, not their numbers, are the primary source of environmental degradation. Begum et al. (2015) Using data from Malaysia from 1970 to 1980, researchers looked at the impact of population on carbon emissions and discovered that there is no discernible connection between population and environmental sustainability. It was found that the emissions were negatively impacted by their anticipated population. Recent studies, including those by Dong et al. (2018) and de Souza Mendonça et al. (2020), have shown the connection between the environment and the people. They concluded that there is a strong long-term correlation between the variables. Wood & Garnett (2009) claimed that compared to rural populations, urban populations have a bigger ecological footprint. They demonstrated that positive GDP shocks have a small impact on environmental degradation using the NARDL panel.

Al-Refaie et al. (2020) and Searle (2020) Discuss how population expansion and development affect how energy consumption is governed. Numerous opportunities that either currently exist or must be created have an impact on the global economy and energy as a result of population expansion. A study by Van Staden & Haslam McKenzie (2021) examines the success of measures to reduce the impact of population expansion on energy use and sustainable economic growth. Through the promotion of sustainable economic growth, the growing population has changed how much energy is consumed. Leading Asian countries' populations are growing their amount of food production, which is good for the viability of the economy. Criado-Gomis et al. (2020) and Q. Liu et al. (2018) Analyze energy consumption and economic evaluation using cultural systems and population increase. They claim that from a strategic standpoint, these structures depend on population expansion as well as sustainable economic development and energy use. This shows that as the population of many countries has increased, the importance of technology, innovation, greater energy consumption, and increased productivity has increased.

CHAPTER THREE

RESEARCH METHODOLOGY

This study's research methodology section describes the approach and methods used to examine the relationships between independent variables (green finance, financial inclusion, financial development, FDI, international trade, and public spending), mediating variables (TI and NRR), and dependent variables (sustainable development and renewable energy). The chosen methodology seeks to provide a systematic and rigorous framework for data collection, analysis, and interpretation. The study uses a quantitative research design to generate empirical evidence and establish quantitative associations between the relevant variables. The research design, data collection strategies, sample plan, and data analysis methodologies are all covered in this part to answer the research questions and achieve the objectives.

3.1 Research Philosophy

A researcher's approach to conducting research and developing current information can be guided by their research philosophy, which comprises the researcher's core beliefs, assumptions, and guiding principles (Saunders et al., 2007). It offers a framework for understanding the nature of reality, the role of the researcher, and the methods utilized to study research issues in business studies. The research philosophy influences the researcher's perspective, which informs their findings' overall design, methods, and interpretation (Onwuegbuzie & Johnson, 2006). Positivism, interpretivism, and critical realism are the primary schools of thought when it comes to conducting research in the field of business studies. Let us take a quick look at these research theories and characterize them.

Positivism is predicated on believing that the world is an objective, observable, and quantifiable reality. It emphasizes quantitative data, scientific techniques, and deduction. Positivist research aims to identify causal relationships, evaluate hypotheses, and generalize findings to a larger population. This philosophy employs structured research designs and statistical analysis to reduce researcher subjectivity and bias (Jamieson, 2008).

Interpretivism, or social constructionism, asserts that reality is subjective and socially constructed. It focuses on comprehending the interpretations and meanings that individuals attribute to their experiences. Exploring the subjective perspectives, values, and cultural contexts of participants, interpretivism research emphasizes qualitative methods such as interviews, observations, and textual analysis. The researcher interacts with participants and recognizes their impact on the research process (Saunders et al., 2007).

Critical realism aims to bridge the distance between positivism and interpretivism. It acknowledges that reality exists independently of human perception, but that social structures and personal interpretations determine our perception of reality. The goal of critical realist research is to identifies the fundamental methods and causal relationships that produce observed phenomena. It utilizes qualitative and quantitative techniques to investigate the context and social structures objectively (Saunders et al., 2007).

Based on the study's purpose to look into how green Finance and sustainable development are related, by using secondary data, positivism is an appropriate research philosophy for this study as positivism focuses on the measurable reality objective. It enables a quantitative and systematic examination of the available data to establish causal relationships between these variables.

3.2 Research Approach

In business studies research, researchers can contribute to the existing corpus of knowledge using a variety of approaches to theory development. Here are three prevalent approaches (Saunders et al., 2007). The inductive approach to theory development entails deriving theories or conceptual frameworks from empirical data-based observations and patterns. Using this methodology, researchers begin with specific data and observations and generate broader theoretical insights through analysis and interpretation. Inductive theory development permits the emergence of novel empirically based concepts and theories (Saunders et al., 2007). The deductive approach to theory development begins with extant theories or established frameworks and evaluates their applicability to research contexts. Using this methodology, researchers begin with broad theories and hypotheses before collecting and analyzing data to confirm or refute these hypotheses. The deductive method enables researchers to refine and extend existing theories by providing empirical evidence to support or modify pre-existing theories (F. A. Shah & Rasli, 2015).

This study uses secondary data best suited for the deductive approach to theory development to investigate the link between sustainable development and green finance. This methodology entails formulating hypotheses based on extant literature and evaluating them by analyzing available secondary data. By employing a deductive methodology, your study ensures a systematic and structured examination of the proposed relationship, thereby contributing to the validation or refinement of existing theories.

3.3 Research Design

According to the positive perspective on research, social science, and business research must be conducted scientifically. This requires following a suitable research design to achieve the study's goals and objectives. Sekaran (2003) identifies four primary categories of research, namely exploratory, descriptive, causal, and correlational research, each of which serves a distinct purpose in the research process. Exploratory research is conducted when there is insufficient extant knowledge, information, or solutions regarding a particular issue. This research design is appropriate for collecting initial, comprehensive data via interviews and observations. Frequently, qualitative methods are employed in exploratory research. Saunders et al. (2007) characterize exploratory research as a flexible and adaptable method that can be adapted to a given circumstance. According to J. F. Hair et al. (2006), there is no predetermined strategy for locating a solution in exploratory research.

Kothari (2004) describes descriptive research as "Ex post facto research" because it employs a research design in which the researcher has no control over the variables. According to Ghauri et al. (2020), descriptive research is used to discover solutions to structured problems and to determine where to look for those solutions. According to J. F. Hair et al. (2006), descriptive research answers queries regarding what, when, who, and why. According to Sekaran (2003), the descriptive research design is handy for describing the characteristics or features of variables within an existing problem. For instance, if the administration of a university is interested in studying variables such as student age, gender ratio, courses studied, and the number of senior and junior students, a descriptive research design would shed light on these aspects.

This study falls under the category of explanatory research because it employs secondary data to provide causal explanations for the association between green finance and climate change. Through quantitative analysis, this study will investigate and explain how changes in green finance may affect the outcomes of climate change. This study provides policymakers, practitioners, and researchers with valuable insights for addressing climate change challenges by contributing to a greater understanding of this causal relationship.

3.4 Nature of Study

When conducting research, it is crucial for a researcher to be specific when choosing a research type, as this choice can impact the results and the level of significance of the research model (Kumar, 2018). Sekaran (2003) identifies quantitative and qualitative research as the two primary categories of inquiry. In contrast, Sekaran's classification (Creswell & Poth, 2016) presents a more inclusive classification of research categories, including quantitative, qualitative, and mixed methods. Creswell & Poth (2016) explains that, within quantitative strategies, there are less rigorous (quasi) experiments and correlational analyses. Additionally, he distinguishes two sub-methods within quantitative strategies: surveys and experiments. Surveys collect information about a specific topic using questionnaires and structured interviews from a sample population.

On the other hand, experimental research seeks to determine the influence of one variable on another. Quantifiable outcomes, conveyed in digits, numbers, and mathematical ratios, are the primary focus of experimental research. According to Creswell & Poth (2016), the qualitative research strategy incorporates a variety of methodologies, such as case studies, grounded theory, ethnographic research, narrative research, and phenomenological research. Ethnography is the appropriate research method when a researcher wishes to examine a cultural group over an extended time. Primary data is gathered through participant observation and in-depth interviews (Creswell & Poth, 2016). Creswell & Poth (2016) further explains that grounded theory research transcends descriptive studies to generate a theory. The term "grounded" suggests that the theory is not preconceived but emerges from the data. In qualitative narrative research, the researcher investigates the events and stories of the participants, arranging and narrating them chronologically (Creswell & Poth, 2016). This explains that narrative studies include a variety of forms, including autobiographies, biographies, life history accounts, and oral histories that concentrate on the life experiences of the research subjects. Case study analysis can also be used to implement the qualitative strategy. According to Sekaran (2003), a case study entails executing a comprehensive and in-depth investigation of a particular issue across multiple organizations. Further, Sekaran, 2003) suggests that case studies address problems and develop theories that can be evaluated through empirical research. According to Creswell & Poth, (2016), when using the case study method in research, the researcher must explicitly identify and define what will be studied concerning the participant or subject under investigation.

Using secondary data, this research employs a quantitative research methodology to investigate the association between green finance and sustainable development. Statistical techniques will be employed to investigate the strength and significance of this relationship through the systematic collection and analysis of numerical data. This strategy permits precise and quantifiable outcomes, enabling evidence-based decision-making and policy formulation.

3.5 Variables

This study has examined the role of financial indicators in encouraging the SDGs and Renewable energy. This study takes green finance, financial inclusion, financial development, public spending, FDI and IT as independent variables, and the dependent variables are sustainable development and renewable energy. This study takes the control variables: population growth, urbanization, trade openness, literacy level, and economic growth as controlled variables; the mediating variables are technological innovation, and natural resources rent.

3.5.1 Dependent Variables

The dependent variables are sustainable development and renewable energy consumption. sustainable development is measured by different indicators, i.e., CO_2 emission, greenhouse gas emission, ecological footprint, and carbon footprint in different contexts (Afzal et al., 2022; Awosusi, Adebayo, Kirikkaleli, Altuntaş et al., 2022; Istraživanja & 2022, 2022; C. Li et al., 2022.; D. Zhang, Mohsin, Rasheed, et al., 2022.). This study has measure sustainable development with all greenhouse gas emissions (Afzal et al., 2022). This study uses Greenhouse gas emissions because many studies use CO_2 emissions to measure sustainable development, but few researchers use it in the relation to sustainable development. The Greenhouse gas emissions data is taken from the World Development Indicators (WDI).

The second dependent variable of the dissertation is renewable energy consumption (RNE). To measure renewable energy, different researchers used different indicators. Some Researchers use wind, solar, hydro, and bioenergy (Croutzet et al., 2021; L. Zhang et al., 2021; Zhou et al., 2022.). Few researchers use RNE consumption percentage of total energy consumption (Dzankar Zoaka et al., 2022; D. Zhang, Mohsin, Economics, et al., 2021). This study has used the RNE consumption percentage of total energy consumption because this study focuses on the total RNE consumption, not the distinct kinds of renewable energy sources. The second model of this study investigates how green financial indicators improve total RNE consumption. The Data on RNE Consumption is taken from the World Development Indicators (WDI).

3.5.2 Independent Variables

Different measures of green finance are used in the literature. Many researchers use the green bond index, investment, credit, and policies to measure green finance (Rasoulinezhad & Taghizadeh-Hesary, 2022b; Saeed Meo & Karim, 2022c). However, few researchers use environmental protection products by residents (C. Li et al., 2022.). This study uses environmental protection products to measure green finance because the data for the other indicators were available for the paid subscriptions. The data on green finance (Environmental protection products by residents) is taken from the OECD Stats.

Other research uses different measures for financial inclusion. The number of automated teller machines (ATMs) per 100,000 people, the number of commercial bank branches per 100,000 people, the number of commercial bank institutions, the percentage of outstanding commercial bank deposits in GDP, and the percentage of outstanding commercial bank loans (percent of GDP) can all be used to measure financial inclusion (FI). These metrics can be combined to create an index (Tian & Li, 2022, N. Amin et al., 2022). Few researchers used only one indicator ATM per one lac people (Zeraibi et al., 2023). Some use four indicators to make an index (T. H. Le et al., 2020b). This study measured financial inclusion with accessibility, availability, and use of banking services. It made the index using the PCA technique, as this measure was used earlier Saleem et al. (2022) and was used in green growth. This study uses the indicator mentioned above because this indicator is widely used in the literature and represents the middle area, i.e., accessibility, availability, and use of banking services of the FI as the definition of FI states as the accessibility of financial services to the general public. The data of different proxies of FI is taken from the World Development Indicators (WDI).

There are various indicators of financial development (FD) in the literature. Some researchers use the financial development index, which was taken from the IMF (Chandio et al., 2022; Pata et al., 2023). Some studies use domestic credit for the financial sector percentage of GDP (Godil et al., 2020a; Jinqiao et al., 2022a; Zameer et al., 2020). This study uses domestic credit to the financial sector percentage of GDP to measure financial development. This study uses this indicator because, through this study, the Author investigates how financial development domestically improves the adoption of renewable energy and plays its role in the sustainability of the environment. The data on FD is taken from the World Development Indicators (WDI).

FDI has different indicators in the literature. Some studies use FDI flows to measure the FDI (Apergis et al., 2022), and others use the FDI net inflow percentage of GDP to measure the FDI (Chandra Voumik & Ridwan, 2023; Rej et al., 2023; She & Mabrouk, 2023; Z. Zhang et al., 2023; Afzal et al., 2022). FDI is measured with the FDI net Flow percentage of GDP because through FDI net inflow, this study will investigate how foreign investment helps promote RNE, combat environmental degradation and help achieve sustainable development goals. The data of FD is taken from the World Development Indicators (WDI).

In literature some researchers measure public spending by making the index of per capital on education and per capita on research and development (Yumei et al., 2021; D. Zhang et al., 2021). Some study uses the government spending percentage of GDP (Fambeu et al., 2022). Some researchers took data of government expenditure in education percentage of GDP and R&D percentage of GDP and made index through PCA, and it was conducted in the European context

(Zhang et al., 2022.). This study choose government expenditure in education and R&D percentage of GDP. The public spending data is taken from the World Development Indicators (WDI).

In the literature international trade is measured with different indicators. Some studies use ratio of the sum of import and export the GDP (Nathaniel et al., 2021). Some studies measure international trade with import and export made index through PCA approach (S. Amin et al., 2021; Ojekemi et al., 2022). This Study uses the indicator import and export made index through PCA approach for the international trade. The public spending data is taken from the World Development Indicators (WDI).

3.5.3 Control Variables

The control variables of the study are population growth, urbanization, trade openness, literacy level, industrialization and economic growth. There are different indicators of trade openness 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.

There are different indicators for these variable in the literature. Some studies measure industrialization by the industry share as a percentage of GDP (Majeed et al., 2020; Xu et al., 2015). Some studies measure industrialization by ratio of industrial value added to the GDP (Yuet al., 2023). This Study measure industrialization by the ratio of industrial value added to GDP as this indicator is rarely used in the nexus between the green finance and sustainable development.

There are different indicators of trade openness 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.

Another control variable is economic growth. Some studies measure economic growth through per capita GDP growth percentage of annual growth (Godil et al., 2020b; Shoaib et al., 2020). This study measure economic growth as annual growth percentage.

The percentage of urban population measures another control variable in Urbanization.in literature urbanization to the total population (Fang et al., 2020; Majeed et al., 2020 (C. Li et al., 2022). This study also used this indicator for the urbanization as it is widely used in the literature

3.5.4 Other Variables

This study takes two mediating variables, i.e., technological Innovation and natural resources rent NRR. To the best of the author's knowledge, these variables are not used as mediators in the nexus between Green financial indicators and climate change but used as the moderating variable by (Jinqiao et al., 2022) in the literature. Several studies use these variables as independent and controlled variables (Awosusi, Adebayo, Kirikkaleli, & Altuntaş, 2022; Jinqiao et al., 2022b; C. Liu et al., 2022). Many Researchers used total patent applications to measure technological Innovation (Dzankar Zoaka et al., 2022; D. Zhang, Mohsin, et al., 2021), but study used medium tech export to measure technological innovation (Lipkova & Braga, 2016). This study will also measure technological Innovation with medium tech export as it is not used in the sustainable development context.

The second mediating variable is natural resource rent (NRR). There are different indicators of NRR in the literature. Some studies measure NRR with the sum of oil rent, natural gas rent, coal rent, and forest rent percentage of the GDP (Medase et al., 2023). Some studies measure natural resource rent with income from natural resources percentage of GDP (Tajuddin et al., 2023), and some measured natural resources with the NRR percentage of GDP (C. Li et al., 2022: Sha, 2023; Wang et al., 2023).

Table 3.1 List of Variables

Dependent Variables	**Notation**	**Indicator**	**Database**
Sustainable Development	SD	GHG Emissions	WDI
Renewable Energy Consumption	REC	Renewable energy consumption % total energy	WDI
Independent Variables			
Green Finance	GF	Environmental Protection Product by Resident	OECD
Financial Inclusion	FI	Atm per lac, Branches per Thousand, bank borrower per lac	WDI
Financial Development	FD	Domestic to the Financial sector	WDI
Public Spending	PS	Education, R&D	WDI
International Trade	IT	Exports, Imports	WDI
Foreign Direct Investment	FDI	FDI net flow	WDI
Control variables			

Population Growth	PG	% Annual Growth of Population	WDI
Urbanization	URB	Urban population % of total	WDI
Industrialization	IND	The ratio of industry value added to GDP	WDI
Economic Growth	EG	% Annual Growth of GDP	WDI
Trade Openness	TO	% Merchandise Export	WDI
Literacy Level	LL	Enroll Students over 15 years	WDI
Other Variables			
Natural Resource	NR	Natural resource Rent	WDI
Technological Innovation	TI	Medium-High Tech export	WDI

3.6 Data, Sampling, and Limitations

3.6.1 Data

This study collected secondary data from multiple sources to conduct the research. The data on green finance was acquired from the OECD website, while the data on other variables was obtained from the World Bank Indicators. The analysis focused on a sample of 66 countries worldwide to maintain consistency and ensure comparability. However, it is essential to note that the availability of data on FI restricted the analysis to the period between 2004 and 2019. These data sources and limitations were considered to give a thorough overview of the research's duration and breadth.

3.6.1 Population and Sampling

Population refers to the target group or entities under study. It represents the larger group from which the data is collected or obtained. The objective of this study is to look at population dynamics worldwide. Although all nations are included in the study's scope, a sample of 66 nations was chosen because they had access to reliable and complete data. The World Bank, OECD, and World Bank are only a few of the respected and reliable data sources used in this study. Since this study offers the most consistent and comprehensive data for the critical variables under consideration for the period of 16 years, from 2004 to 2019. This study acknowledges the constraints imposed by the lack of data by concentrating on a selection of nations for which statistics are available while attempting to offer relevant insights about global population trends and patterns.

Sampling can be defined as the application of a particular set of criteria to select countries from a population for an investigation. In the correct context, it has been pointed out that "because many of the populations of interest are too vast to work with directly, several statistical sampling procedures have been developed to collect samples taken from larger populations". When countries are selected for the study based on criteria such as ease of access, closeness to the study's geographic area, availability at a specific time, or desire to participate, this method of choosing is known as convenience sampling (Dörnyei & Griffee, 2010). This study uses the convenience data sampling technique as this study collects the data based on the availability of the data.

To draw conclusions that are meaningful, the representative sample must be sufficient. In other words, it is the size at which an estimation of the appropriate population proportion may be made with the necessary margin of error and level of confidence. As a result, choosing the right sample size is a common issue in statistical analysis. Total population, the p - value of the normally distributed, sample proportion, and error margin can all be used to obtain the equation.

$$Sample\ Size\ (n) = \frac{\frac{N * [Z^2 * p * (1-p)}{e^2}}{\frac{N - 1 + [Z^2 * p * (1-p)}{e^2}}$$

The sample size calculated from the population of 210 countries is 60 at the minimum range but this research took 66 countries based on data availability and across the globe. As climate change is a global issue in that context, this study considers the world population. However, all nations are included in the study's scope for policy implications; a sample of 66 nations is selected due to the access to reliable and complete data. The World Bank database and OECD are only a few of the respected and reliable data sources used in this study. Since this period offers the most consistent and comprehensive data for the study period includes 16 years, from 2004 to 2019. This study acknowledges the constraints imposed by the lack of data by concentrating on a selection of nations for which statistics are available while attempting to offer relevant insights about global trends and patterns.

3.6.3 Data Transformation

To meet the requirement of statistical data analysis, different research apply different data transformation techniques. Some studies take square root of few or all variables (H. Feng & Yang, 2023; Guang-Wen & Siddik, 2023) and some studies take natural logarithmic transformation (Bakry et al., 2023; Z. Cheng et al., 2023). In order to meet the requirements of statistical analyses and improve the suitability of the data for analysis, various data transformation techniques were applied. Natural logarithmic transformation and square root transformation were used for the different variables used in the study.

3.7 Theoretical Framework

It is believed that shocks to various macroeconomic variables will cause both homogeneous and heterogeneous environmental repercussions. It is important to relate these affects using applicable theoretical underpinnings so that we can get a better understanding of the specific nature of these effects. Green finance, also known as environmental sustainability, can be accomplished in the case of public or private investment by either increasing revenue or emphasizing financial inclusion; however, these two approaches each have advantages and disadvantages. Cash flow is crucial in every respect, including from the people's point of view, the business's perspective, and the situation's perspective. Diversification as a strategy and manufacturing expansion increase the number of operational processes, each with higher energy requirement (B. Shen et al., 2020). This results in superior FD. It is well known that non-renewable natural resources are responsible for 80% of worldwide energy consumption (Z. Liu et al., 2018).

Furthermore, A rise in GHGs and other greenhouse gases may result from the widespread use of these alternative energy sources (X. Hao et al., 2021). The problem of climate change has been made worse by GHGs emissions from various non-renewable energy sources, which has ozone as a direct outcome, leading to the degradation of the environment (Imtiaz & Shah, 2008). It is widely accepted across the body of scholarly research on RNE and GHGs emissions that the environmental impact of RNE is noticeably lower when compared to that of fossil fuels like petroleum, gasoline, and charcoal. According to the findings of the most recent studies, it is anticipated that REC will have a detrimental impact on the amount of GHGs emissions.

The theoretical foundations of the EKC hypothesis can be used to explain the link between renewable energy and carbon production (Grossman & Krueger, 1991b). Generally, this concept refers to technical breakthroughs that eliminating the swap among economic growth and environmental degradation (Tenaw & Beyene, 2021). In this context, the transition to RNE driven by technical advancements within an economy is anticipated to result in a reduction in the consumption of polluting fossil fuels and an increase in the utilization of RNE. Because of this, it is presumable that rising the share of energy derived from RNE sources within the national energy portfolio will stimulate economic expansion while simultaneously raising carbon productivity. This beneficial effect of renewable energy on the environment can also be explained by the fact that most RNE resources don't contain hydrocarbons. As a result, the burning of these resources does not result in the emission of significant quantities of GHGs into the atmosphere. On the other hand, fossil fuels are loaded with hydrocarbons, and because of this, the utilization of these energy sources increases emissions. However, it should be emphasized that conventional fossil fuels are often considered to be more cost-effective fuel sources than RNE supplies, which are generally considered to be substantially more expensive. Consequently, using RNE sources will likely result in more significant expenses associated with energy input. In this context, increasing the use of RNE sources may not necessarily ensure improvements in carbon productivity. This is since more significant production costs tend to slow down production levels.

Furthermore, the national income accounting theory, which stresses that output is conditioned on consumer, investment, public spending, and net export levels, can help us understand the impact of financial inclusion on carbon productivity (Asheim et al., 2007). This theory explains that output depends on consumption, investment, and net export levels. Because greater financial inclusion is linked to higher levels of consumption and investment, it is projected that the demand for energy would rise. In this aspect, whether the increase in energy demand is met by RNE or NRNE sources will affect the environment. For example, if the demand is met using RNE sources, the environmental effects will differ. If increased levels of financial inclusion make it easier for investments to be made in environmentally friendly initiatives, this could lead to higher levels of output production in exchange for lower carbon emissions. Under these conditions, there is a good chance that the levels of GHGs productivity will increase. On the other hand, if the expansion of polluting industries is facilitated by financial inclusion, this may lead to an increase in output production while also leading to an increase in carbon dioxide emission levels concurrently. As a direct consequence of this, the levels of GHGs productivity are likely going to decrease.

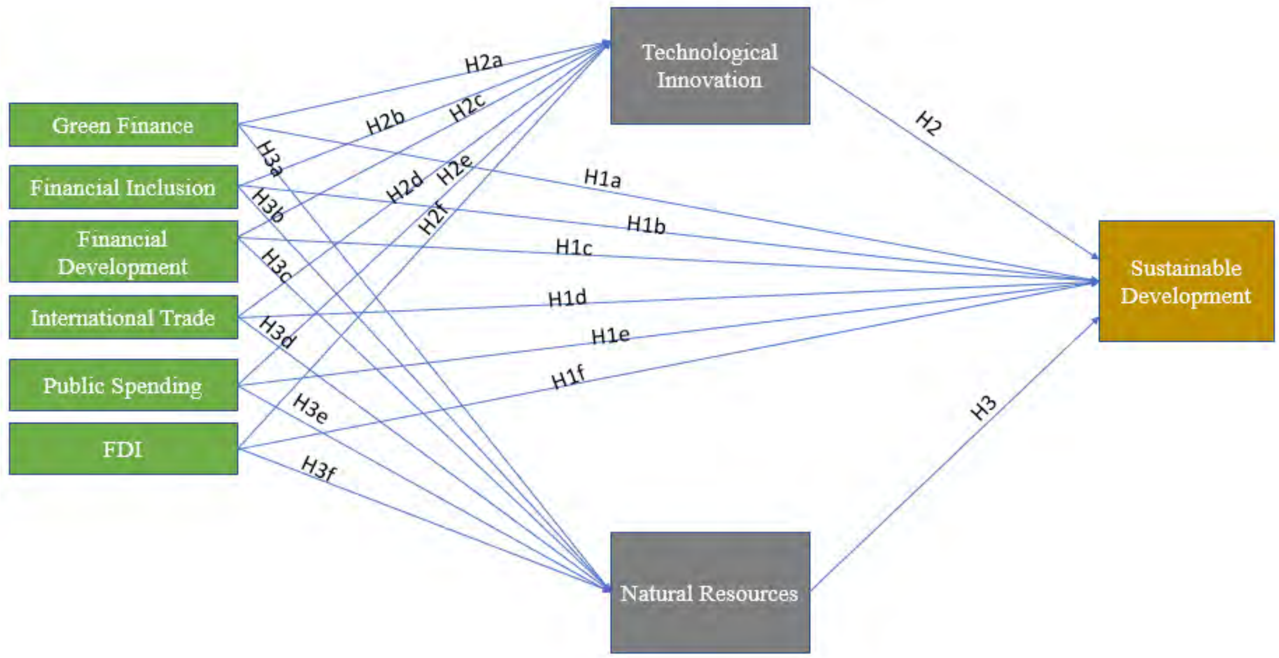
It is also possible to use the environment kuznte curve (EKC) hypothesis theory to explain how other key macroeconomic factors might affect carbon productivity. This is something that can be done by using the theory. For example, during the size, compositional, and technique effects, it is argued that economic expansion first causes increased carbon dioxide emissions. However, these emissions eventually reduces with the economic growth (I. Yasin et al., 2021). This is because of the scale effects. In this respect, economic expansion can also be associated with lower carbon productivity at first (during the stage where economic growth is given precedence over environmental deterioration), and higher carbon productivity at a later stage. On the other hand, the concept of comparative advantage in trade has the potential to establish a relationship between increasing carbon productivity and global trade integration. Globalization, especially in international commerce, benefits economic growth in the economies that participate in it (Osei-Assibey & Dikgang, 2020), which has mainly been acknowledged in the relevant academic research.

On the other hand, the associated impact on the environment can be somewhat variable (Hübler, 2017). This is because countries with a plentiful supply of fossil fuels are probably to have a competitive advantage in producing commodities that need a lot of fossil fuel. Because of this, international commerce would lead to an expand the number of polluting industries within individual nations, which, in turn, would have the effect of lowering the overall levels of carbon productivity to a significant degree. In contrast, IT may also be responsible for improving the level of carbon productivity in nations that have a comparative advantage in using clean energy resources to produce output.

3.7.1 Theoretical Framework of Model 1

The first model in the theoretical framework examines the association among the dependent variable sustainable development and the independent variables green finance, financial inclusion, financial development, FDI, international trade, and public expenditure. SD, which incorporates economic, social, and environmental dimensions, is a crucial objective for all societies. This model intends to investigate how selected independent variables assist in reaching the objectives of sustainable development. Green finance, FI, FD, FDI, IT and public expenditure are all recognized as potential drivers of sustainable development, and understanding their roles and interrelationships is essential for formulating effective policies and strategies. By examining the relationships between these variables, Model 1 aims to shed light on the factors that influence sustainable development outcomes and inform decision-making processes to foster a more sustainable and inclusive future.

Figure 3.7 Theoretical Model 1

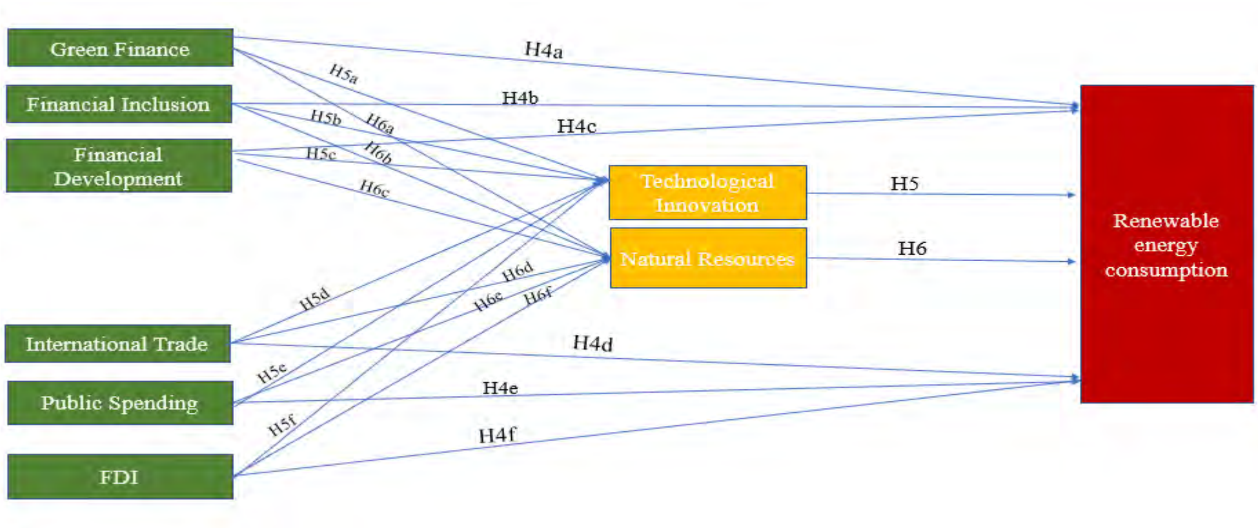


(Adapted from C. Li et al.,2022)

3.7.2 Theoretical Model 2

The second theoretical framework model examines the association of the dependent variable of RNE consumption and the independent variables of green finance, financial inclusion, FD, FDI, IT, and public expenditure. As the global transition to RNE sources acquires momentum, comprehending the factors that drive RNE consumption is of the utmost importance. This model intends to investigate how the selected independent variables affect the adoption and utilization of RNE technologies. Green finance, financial inclusion, FD, FDI, IT and public expenditure are all potential determinants of the development and deployment of renewable energy systems. By examining the associations between these variables, Model 2 aims to shed light on the policies, interventions, and mechanisms that can promote renewable energy consumption. This comprehension is essential for promoting sustainable energy practices and mitigating the adverse effects of fossil fuel dependence, contributing to a more sustainable and resilient energy future.

Figure 3.8 Theoretical Framework of Model 2



(Adapted from Kirikkaleli et al., 2022)

3.8 Econometric Model

This section provides a mathematical representation of the relationships between the independent variables (green finance, financial inclusion, financial development, FDI, international trade, and public spending), the mediating variables (TI and NRR), and the dependent variables (sustainable development and renewable energy). This section employs statistical methods to estimate the quantitative impact of these variables on sustainable development and renewable energy consumption. Through the formulation of an econometric equation, the study seeks to provide empirical evidence and insights into the key drivers and mechanisms that shape these relationships, thereby supporting evidence-based decision making and policy formulation in the pursuit of sustainable and renewable energy solutions.

3.8.1 Model 1

This model shows the influence of green financing on the GHGs emissions. Equations 2 & 3 are extensions of Equation 1, which include the mediation of TI and NRR and the control variables. This model is adapted from the Study (D. Zhang et al.,2021) and expanded.

$$GHGs = f\,(GF, FI, FD, IT, FDI, PS) \qquad (3.1)$$

The above function ins for the model 1 implies that the GF, FI, FD, FDI and international trade influence the GHGs emissions.

The above function is for the model 2 that implies that the green finance, financial inclusion, FD, FDI, and international trade influence the REC consumption.

$$GHGs_{it} = \beta_0 + \beta_1 GF_{it} + \beta_2 FI_{it} + \beta_3 FD_{it} + \beta_4 IT_{it} + \beta_5 FDI_{it} + \beta_6 PS_{it} + \mu_{it} + \varepsilon_{it}. \qquad (3.2)$$

Where I and t stand for individual nations and eras, respectively. The erroneous term is (εit). β is vector for the independent variables. GF indicates green finance, FI indicates Financial Inclusion, FD indicates Financial Development, IT indicates international trade, FDI indicates Foreign Direct Investment and PS indicates Public Spending.

$$GHGs_{it} = \beta_0 + \beta_1 GF_{it} + \beta_2 FI_{it} + \beta_3 FD_{it} + \beta_4 IT_{it} + \beta_5 FDI_{it} + \beta_6 PS_{it} + MV_{it}\partial_1 TI_{it} + \partial_2 NR_{it} + \mu_{it} + \varepsilon_{it} \qquad (3.3)$$

MV represents the mediating variables and δ is vector for mediating variables. TI indicates Technological Innovation and NR indicates Natural Resources. The static panel model ignores mediation effects of technological Innovation and natural resource rent. It is also possible for there to be a bidirectional causal connection between the explanatory variable and the variable being explained in the static panel model.

$$GHGs_{it} = \beta_0 + \beta_1 GF_{it} + \beta_2 FI_{it} + \beta_3 FD_{it} + \beta_4 IT_{it} + \beta_5 FDI_{it} + \beta_6 PS_{it} + MV_{it}\partial_1 TI_{it} + \partial_2 NR_{it} + C_1 URB_{it} + C_2 PG_{it} + C_3 TO_{it} + C_4 EG_{it} + C_5 IND_{it} + C_6 LL_{it} + \mu_{it} + \varepsilon_{it} \quad (3.4)$$

C represents the controlled variables. URB indicates Urbanization, TO indicates Trade Openness, PG indicates Population Growth, EG indicates Economic Growth, IND indicates Industrialization and LL indicates the literacy Level.

3.8.2 Model 2

This model shows the influence of green financing on the Renewable energy consumption. Equations 5 & 6 are extensions of Equation 4, which include the mediation of TI and NRR and the control variables. This model is adapted from the Study (D. Zhang et al.,2021) and expanded. The dynamic panel regression model used in this study is described as follows.

$$RNEC = f\,(GF, FI, FD, IT, FDI, PS) \quad (3.5)$$

$$RNEC_{it} = \beta_0 + \beta_1 GF_{it} + \beta_2 FI_{it} + \beta_3 FD_{it} + \beta_4 IT_{it} + \beta_5 FDI_{it} + \beta_6 PS_{it} + \mu_{it} + \varepsilon_{it} \quad (3.6)$$

Where I and t stand for individual nations and eras, respectively. The erroneous term is (εit). β is vector for the independent variables. RNEC is the explained variable, which reflects the renewable energy of the i-th country in year t. GF indicates green finance, FI indicates Financial Inclusion, FD indicates Financial Development, IT indicates international trade, FDI indicates Foreign Direct Investment and PS indicates Public Spending.

$$\mathrm{RNEC}_{it} = \beta_0 + \beta_1 \mathrm{GF}_{it} + \beta_2 \mathrm{FI}_{it} + \beta_3 \mathrm{FD}_{it} + \beta_4 \mathrm{IT}_{it} + \beta_5 \mathrm{FDI}_{it} + \beta_6 \mathrm{PS}_{it} + MV_{it}\partial_1 TI_{it} + \partial_2 NR_{it} + \mu_{it} + \varepsilon_{it} \quad (3.7)$$

MV represents the mediating variables and δ is vector for mediating variables. TI indicates Technological Innovation and NR indicates Natural Resources. The static panel model ignores mediation effects of technological Innovation and natural resource rent. It is also possible for there to be a bidirectional causal connection between the explanatory variable and the variable being explained in the static panel model.

$$\mathrm{RNEC}_{it} = \beta_0 + \beta_1 \mathrm{GF}_{it} + \beta_2 \mathrm{FI}_{it} + \beta_3 \mathrm{FD}_{it} + \beta_4 \mathrm{IT}_{it} + \beta_5 \mathrm{FDI}_{it} + \beta_6 \mathrm{PS}_{it} + MV_{it}\partial_1 TI_{it} + \partial_2 NR_{it} + C_1 URB_{it} + C_2 PG_{it} + C_3 TO_{it} + C_4 EG_{it} + C_5 IND_{it} + C_6 LL_{it} + \mu_{it} + \varepsilon_{it} \quad (3.8)$$

C represents the controlled variables. URB indicates Urbanization, TO indicates Trade Openness, PG indicates Population Growth, EG indicates Economic Growth, IND indicates industrialization, and LL indicates literacy Level.

3.9 Descriptives Statistics

3.9.1 Descriptives Statistic Model 1

This section provides a brief overview of the descriptive statistics compiled for the variables that are part of the dataset. The statistics include measures of central tendency such as the mean, which indicates the average value, and the standard deviation, which represents the degree to which the values can vary. Both measures are included in the statistics. In addition, the lowest and maximum values bring attention to the range covered by each variable. This draws attention to the distribution and spread of the values.

Table 3.2 Descriptive statistics

Variable	N	Mean	Std	Min	Max
GHGs	1,056	11.4923	1.66547	7.53903	16.3575
GF	1,056	2.50966	0.66197	0.02956	4.60517
FI	1,056	0.78589	0.61789	0.00094	4.28222
FD	1,056	1.7386	0.3638	-0.7301	2.48369
IT	1,056	0.71067	0.70319	0.00142	5.91781
FDI	1,056	22.1839	1.94967	12.9417	27.3215
PS	1,056	0.80314	0.59527	0.00271	3.74098
TI	1,056	3.48217	0.99485	-3.2838	4.42746
NRR	1,056	1.65501	1.80375	0	8.16414
IND	1,056	3.31271	0.35934	2.30105	4.31498
LL	1,056	4.51939	0.26835	3.11402	5.09947
PG	1,056	1.12975	1.5114	0.0002	17.5122
TO	1,056	4.1912	0.49026	2.99516	5.83913

Table 3.2 gives descriptives statistical information on 66 nations using panel data collected from 2004 to 2019. The results include statistical data that includes the mean, standard deviation, and standard statistics. The results of table 3.1 show the mean, standard deviation of the variable. Results show the highest mean for greenhouse gases (FDI) and the lowest for international trade. Results indicate that foreign direct investment shows the highest standard deviation while the

lowest standard deviation was financial development. The table indicates the Mean of GF (2.5), FI (0.78), FD (1.738), IT (0.710), PS (0.803), while standard deviation are GHGs (1.66), GF (0.661), FI (0.617), FD (0.3638), IT (0.70), FDI (1.94) and PS (0.595). The mean and standard deviation for control and mediation variables are shown in Table 3.2.

3.9.2 Descriptives Statistics Model 2

This section provides a brief overview of the descriptive statistics compiled for the variables that are part of the dataset. The statistics include measures of central tendency such as the mean, which indicates the average value, and the standard deviation, which represents the degree to which the values can vary. Both measures are included in the statistics. In addition, the lowest and maximum values bring attention to the range covered by each variable. This draws attention to the distribution and spread of the values.

Table 3.3 Descriptive statistics

Variable	N	Mean	Std.	Min	Max
RNEC	1,056	3.90	2.26	0.00	9.56
GF	1,056	2.51	0.66	0.03	4.61
FI	1,056	0.79	0.62	0.00	4.28
FD	1,056	4.01	0.82	0.24	5.72
IT	1,056	0.71	0.70	0.00	5.92
FDI	1,056	22.18	1.95	12.94	27.32
PS	1,056	0.80	0.60	0.00	3.74
TI	1,056	3.48	0.99	-3.28	4.43
NRR	1,056	5.99	11.74	0.00	66.65
PG	1,056	1.13	1.51	0.00	17.51
TO	1,056	4.19	0.49	3.00	5.84
EG	1,056	3.86	4.59	-27.99	53.38
URB	1,056	64.58	20.61	14.84	100.00

Note: Table 3.3 displays descriptive statistics for the variables in actual (raw) values for the 66nations from 2004 to 2019.

The descriptive statistics about our variables are included in Table 3.3. The statistics obtained from the samples indicate that the mean values for renewable energy consumption (RNEC), green finance (GF), financial inclusion (FI), financial development (FD), international trade (IT), foreign direct investment (FDI), and public spending (PS) are 3.90, 2.51, 0.79, 4.01, 0.71, and 22.28 respectively. Tale 1 also displays the standard deviation for the data of different variable. The standard deviation of the variables is not high that indicates that there is extraordinarily little heterogeneity among the sample of the countries for the selected variables.

3.10 Analysis Tools and Techniques

This section presents a brief overview of the critical tools and techniques employed in this study's analysis. In order to properly apply an econometric analysis method, one needs to have an in-depth understanding of the basis of the data collection. As a result, screening in the beginning is essential. This validation will be a reference for determining the proper approach (or techniques), so have it handy. This study employs a range of analytical tools and methodologies to explore and analyze the data in our study. These tools and techniques enable us to gain meaningful insights, uncover patterns, and draw robust conclusions from our dataset.

3.10.1. Descriptive statistics

A descriptive statistics is a brief expressive coefficient summarizing a given information set. This information set can illustrate the entire population or only a sample. We can determine the measure of deviation and central tendency while working with descriptive statistics. The minimum value, the maximum value, the standard deviation, and other values are all included in the deviation measures. whereas the measurements of central tendency comprise, respectively, the mean value, the median value, and the mode value. Descriptive statistics are statistics that describe and summaries the behavior of the variables that were employed in the study.

3.10.2. Multicollinearity test

When two or more of the relevant components in a model with multiple regression are highly linked, a phenomenon known as multicollinearity may occur (Greene, 2003). This phenomenon has the potential to be measured. When there is a perfect linear connection between multiple variables, there is an issue known as multicollinearity (Gujarati, 2022). A multicollinearity problem exists the bivariate regression coefficients between combined indicator components is high, exceeding 0.80 (Hamilton, 2012). This indicates that the factors are highly correlated with one another. Contrasting explanatory factors should not correlate too highly because if they do, the evaluated parameter will become unreliable, and the indicators will become less significant (Field, 2009). Building a correlation matrix is one of the methods that can be utilized in the search for multicollinearity. The matrix of correlations of variables displays the correlation of the variables used to explain the phenomenon. According to Field, (2009) rule of thumb, a correlation scores higher than 0.8 might raise some red flags. It gives a relationship both direction and strength, providing both simultaneously.

3.10.3. Heteroscedasticity test

According to J. Hair, (2009) research, the terms homoscedasticity and heteroscedasticity have their roots in Greek and refer, respectively, to the equality and inequality of the variability of the error term in regression equations. When performing regression, the variables chosen at random are assumed to have a distribution that is identical to one another and independent of one another. This indicates that these variables have some degree of variation for each observation in a given data set. This pattern of behavior is referred to as homoscedasticity. When they are not, it creates significant problems for the estimations, which necessitates the need for adjustments for researchers to obtain reliable figures. Heteroscedasticity can occur when the model's parameters are erroneous, or the data transformation is done incorrectly. Because of this, there is a shift in the variance of the variable that is being depended on dependent variable (J. Hair, 2009). In practice, heteroscedasticity may appear if different observations have varying error variances. In each of the regression models, the Breusch-Pagan or Cook-Weisberg test was used in order to determine whether or not the residual variance exhibited heteroscedastic behaviors. If the value p-value is less than 0.05 percent, it indicates a problem with heteroscedasticity in the variance of the dependent variables. As a result, the model ought to be regressed utilizing the least square estimator in conjunction with robust standard regression.

3.10.4 Slope of Homogeneity

In the context of panel regression models, it is common to assume that the slope coefficients remain consistent across the entire cross-section. However, it is essential to acknowledge that this assumption may not always hold in real-world scenarios, leading to potential inconsistencies and misleading interpretations (Blomquist & Westerlund, 2016; Hsiao, 2022). Thus, it becomes crucial to examine the validity of the slope homogeneity assumption before further analysis.

In this study, authors conduct tests to examine the presence of slope heterogeneity using two widely recognized approaches: the Pesaran and Yamagata (M. Pesaran et al.,2007) test and the (Blomquist et al., 2013). Heteroskedasticity and Autocorrelation Consistent (HAC) robust test. These tests provide valuable insights into the potential variations in slope coefficients across the cross-section of our panel data

3.10.5 Panel Cross-sectional dependence

The OLS assumptions that the residuals are independently distributed and homoscedastic must be thoroughly examined. Most of the earlier research assumed that flaws in the data are uniformly distributed across the board. On the other side, this might not be the case in actuality. Consequently, the results from such an improper analysis will be misleading. Methods such as the pooled Mean group (PMG), Fixed effcet (FE), and the Generalized method of moment (GMM) have been utilized in the research published so far to alleviate the symptoms of this problem.

Nevertheless, these methods do not fully take into consideration the CD that is present in the data. When particular economic data of a specific cross-sectional group (or country) depends on similar economic data of other cross-sectional units, problems can arise due to cross-sectional dependence (Murshed, Mahmood, et al., 2020). According to Chudik et al. (2016), the primary elements that are responsible for CD include, in addition to spatial spillover effects, neglected standard components, and socioeconomic network. It is essential to evaluate the CD in the context of the selected 66 countries because of the interconnected nature of these nations in terms of both their economies and their policies. Because of this, neglecting the possibility of CD problems may result in biased estimations and erroneous results. As a result, the CD test developed by (M. H. Pesaran, 2004) is utilized in this investigation as suggested by Li et al. (2020). The CD statistic can be specified in several separate ways.

$$\mathrm{CD} = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=0}^{N-1} * \sum_{j=i+1}^{N-1} * \rho ij\right) N(0,1), \quad (3.9)$$

N represents the cross section and T represents the temporal horizon, respectively. ij represents the inaccuracy that occurs due to the correlation of the cross sections for i and j. The size of the data set used in this study, which has fewer periods than the cross sections under study (N > T), led the author to choose this particular approach.

3.10.6 Panel Unit Root

If the CD issue is verified, utilizing the first-generation unit roots methodologies is deemed unsuitable because these methodologies cannot account for the CD issues adequately. Therefore, the Cross-sectional Augmented Dickey–Fuller (CADF) and Cross-sectional augmented Im–Pesaran–Shin (CIPS) second-generation panel unit root tests developed by (M. H. Pesaran, 2007) are utilized in order to make up for this shortcoming. These strategies account for the CD difficulties in the estimating procedures, distinguishing them from the first-generation methods (Ng et al., 2020). As a result, these methods are superior to the first-generation methods. The CADF and CIPS tests have been utilized by several researchers in more recent research (Murshed & Dao, 2022; Naqvi et al., 2020), to determine the qualities of the unit root. The CADF method involves adding unobservable common factors into the model to control for CD concernsn the data (M. H. Pesaran, 2007). The generalized regression function, which is presented in the following, can be used to produce the CADF test statistic:

$$\Delta y_{it} = a_i + b_i y_{i,t-1} + c_i \overline{y}_{t-1} + \sum_{j=0^*}^{s} d_{ij} \Delta \overline{y}_{t-j} + \sum_{j=1^*}^{s} \delta_{ij} \Delta \overline{y}_{i,t-j} + e_{it}, \quad (3.10)$$

where y and Δy is the average of the cross-sectional outcome variables at the lagged levels, and y is the average of the cross-sectional outcome variables at the first differences. The computed CIPS statistic, which can be stated as, is then determined using the estimated t-statistic that was derived from Equation (3.10)

$$\text{CIPS} = N^{-1} \sum_{i=1}^{N} . \ \text{CADF}_i, \quad (3.11)$$

CADFi is the t-statistic calculated based on the CADF regression model described in Eq. (3.9). Both the CADF and CIPS tests are conducted assuming that the respective variable does not exhibit stationarity. In order to contrast the alternative hypothesis of stationarity with the null hypothesis of non-stationarity, this is done. Once the variables' integration orders have been established, it is crucial to use the appropriate co-integration techniques to look for long-term correlations between them. This can be done once the order of integration has been determined.

3.10.7 Panel Cointegration

There is a chance of long-run relationships between the variables if it can be established that they share a standard order of integration, ideally at the first difference. This will increase the likelihood that the relationships will exist. As a result, it is essential to examine the various models to determine whether or not they contain co-integrating equations. The first-generation co-integration techniques' estimation procedure, much like the first-generation panel unit root methods' estimation procedure, cannot accommodate the CD concerns. In light of this, the alternatives of the second generation are the ones that are best suited for determining the cointegrating features. In light of this, the Murshed, (2020) Murshed, Chadni, et al. (2020); Murshed, Mahmood et al. (2020) & Usman et al. (2020) studies serve as the foundation for the application of the Westerlund et al. (2007) second-generation panel cointegration test. According to Westerlund et al. (2007), the capability of this method to account for CD difficulties and the nuisance that results from endogeneity makes it preferable to the methods of the first generation. The Westerlund et al. (2007) approach takes a bootstrapped approach, which allows it to address the CD concerns (Altıntaş & Kassouri, 2020). Four statistics are estimated using the null hypothesis, which states no cointegration between the variables of concern, and the alternative hypothesis, which states that there are cointegrating correlations between the variables. Two of the four statistics are group mean statistics, which evaluate the cointegration of the entire panel. This cointegration test can be demonstrated as follows:

$$G_\tau = \frac{1}{N}\sum_{i=1}^{N} \frac{\overline{\alpha_i}}{\mathrm{SE}(\overline{\alpha_i})} \text{ and } G_\alpha = \frac{1}{N}\sum_{i=1}^{N} \frac{T\overline{\alpha_i}}{\overline{\alpha_i}(1)}. \quad (3.12)$$

The other two statistics are the panel mean test statistics, and they investigate whether or not cointegration exists in at least one of the units. These can be further broken down into:

$$P_\tau = \frac{\overline{\alpha_i}}{\mathrm{SE}(\overline{\alpha_i})} \text{ and } P_\alpha = T\overline{\alpha}. \quad (3.13)$$

The semiparametric kernel estimator of the value αi is the value αi (1), and the standard error of the value αi is denoted by the value SE (αi).

3.10.8 Fully modified ordinary least square method (FMOL) Estimation

The FMOLS (Fully Modified Ordinary Least Squares) estimation method is especially advantageous when dealing with cointegrated panels because it addresses two fundamental issues: endogeneity bias and serial correlation. By considering these factors FMOLS offers dependable and effective long-run relationship estimators. In the case of heterogeneous cointegrated panels, where the cointegration relationship can differ between individuals or cross-sections, FMOLS is thought to be the most appropriate approach. It accounts for diverse cointegrating vectors in dynamic panels, corresponding to the cross-sectional heterogeneity observed in recent panel unit root and panel cointegration research (Hamit-Haggar, 2012).

Comparing the asymptotic properties of several estimators based on aggregating along the panel's "within" and "between" dimensions reveals FMOLS to be a reliable method for estimating cointegrating relationships in heterogeneous panel data. When cointegrated panels are present, it overcomes endogeneity bias and serial correlation to enable reliable and effective estimation of the long-run connection between variables (Pedroni, 2001).

3.10.9 *Dynamic ordinary least squares* (*DOLS) Estimation*

The PDOLS (Panel Dynamic Ordinary Least Squares) estimator is a method that extends the DOLS technique for individual time series. DOLS is an uncomplicated and efficient method for estimating the cointegrating vector, representing the long-run relationship between variables. While DOLS is typically applied to nonstationary data with a cointegrating relationship, the PDOLS estimator extends its use to panel time-series data. This permits data analysis exhibiting nonstationary and co-integration across multiple cross-sectional units. Scholars can use the PDOLS method to estimate the cointegrating vector in panel time-series data while considering the dataset's dynamics and potential cross-sectional heterogeneity. Adding DOLS to panel data enables examining long-run relationships across multiple entities or cross-sections, thereby revealing the common factors that drive the variables of interest (Neal, 2014).

CHAPTER FOUR

BASIC DATA ANALYSIS

In this chapter, we delve into the fundamental data analysis conducted as part of this research, aiming to provide a comprehensive understanding of the primary data set used. The analysis encompasses various statistical techniques and exploratory approaches to uncover patterns, trends, and relationships within the data. By examining key variables, descriptive statistics, and data visualizations, this analysis lays the foundation for subsequent in-depth investigations and hypothesis testing. The insights gained from this basic data analysis will inform the subsequent chapters and contribute to a robust and evidence-based research framework. Through this chapter, we aim to provide a solid understanding of the data characteristics, facilitating a deeper exploration of the research questions and objectives.

4.1 Basic Analysis Model 1

4.1.1 VIF & Correlation Matrix

Problems with multicollinearity arise when the independent variables are significantly associated with one another. When the degree of multicollinearity among variables is significant, the standard error of the regression coefficient rises, reducing the statistical reliability of these coefficients. Nonetheless, the most dependable statistical test for multicollinearity is an analysis of Variance Inflation Factor (VIF) with thresholds below 10 (J. Hair, 2009). To find the link among the dependent and independent variables of a study, the correlation matrix is computed. The following table 4.1 depicts VIF & correlation matrix results.

Table 4.1 VIF & Correlation Matrix

Var	VIF	GHGs	GF	FI	FD	IT	FDI	PS	TI	NRR	PG	IND	LL	TO
GF	1.03	0.01	1.00											
FI	1.07	-0.01	0.05	1.00										
FD	1.88	0.04	0.05	0.05	1.00									
IT	1.23	-0.02	0.02	-0.05	0.04	1.00								
FDI	1.47	0.51	0.08	-0.03	0.44	0.18	1.00							
PS	1.09	0.02	-0.05	-0.11	0.04	-0.09	-0.05	1.00						
TI	1.76	0.09	0.09	-0.13	0.50	0.05	0.40	-0.07	1.00					
NRR	2.95	0.29	-0.01	0.02	-0.41	-0.12	-0.17	0.00	-0.36	1.00				
PG	1.39	-0.01	-0.04	0.00	-0.17	0.10	-0.13	0.07	-0.17	0.47	1.00			
IND	2.73	0.39	0.03	-0.03	-0.30	-0.05	0.00	0.01	-0.17	0.75	0.42	1.00		
LL	1.75	-0.16	0.10	-0.07	0.50	-0.02	0.30	0.03	0.51	-0.25	-0.17	-0.20	1.00	
TO	1.4	-0.27	0.04	-0.04	0.08	0.27	0.07	-0.16	0.22	-0.03	0.01	0.14	0.30	1.00

The above table 4.1 represents the results of the VIF and Correlation matrix. These results indicated that there is no threat multicollinearity among the variables as the VIF values are less than 10. the VIF value for the GF (1.03), FI (1.07), FD (1.84), IT (1.23), FDI (1.47) and PS (1.09) as shown in table 4.1. The correlation matrix amongst the dependent and independent variables is shown in table 4.1. Observations indicate that the variables correlate well. According to the correlation results, GF, FD, FDI, PS are positively correlated with GHGs while FI and IT are negatively correlated with the GHGs having coefficients ranging between 0.01 to 0.51.

4.1.2 CD test

The CD test is used to determine whether or not there is cross-sectional dependency, which means whether or not there is a correlation or interdependence among the observations in the dataset, which may or may not have an impact on the validity of the statistical analysis you are performing. The findings of the tests are brief in the table that follows:

Table 4.2 CD Test

	CD Test	
Variable	**Pesaran (2007) CD**	**Pesaran (2004) CD**
GHGs	1.541	1.54
GF	-0.872	-0.87
FI	5.418***	5.42***
FD	20.811***	20.81***
IT	-0.005	-0.09
FDI	18.884***	18.88***
PS	0.388	0.39
TI	7.61***	0
NRR	57.666***	0

Note ***, ** & * represents 1%, 5% & 10% significant level

The above table shows the results of the CD test. In the Pesaran (2007) test, the CD tests for GHGs suggest a value of 1.541, whereas in the Pesaran (2004) test, the result is 1.54. These values are not high enough to achieve statistical significance, indicating that there is no substantial cross-sectional dependency for the GHGs variable. The results of the CD tests for GF indicate values of -0.872 for the Pesaran (2007) tests and -0.87 for the Pesaran (2004) tests, respectively. In a manner comparable to that of GHGs, the results do not attain statistical significance, which indicates that the GF variable does not exhibit any significant cross-sectional dependency. The results of the CD tests for FI indicate that the numbers 5.418 and 5.42 for the Pesaran (2007) and Pesaran (2004) tests, respectively, are extremely significant. These findings point to the possibility of the existence of a cross-sectional dependency for the FI variable. The CD tests for FD show incredibly significant scores of 20.811 and 20.81 for the Pesaran (2007) and Pesaran (2004) tests, respectively. Both of these tests were conducted by Pesaran. This demonstrates that a cross-sectional dependency exists for the FD variable. The CD tests for information technology exhibit results of -0.005 for the Pesaran (2007) tests and -0.09 for the Pesaran (2004) tests, respectively. Both of these values fall short of the statistical threshold for significance, which indicates that there is no significant correlation between the two cross-sections for the IT variable. The Pesaran (2007) and Pesaran (2004) tests both indicate highly significant values for the CD tests for FDI, with 18.884 and 18.88, respectively. This provides evidence that the FDI variable does, in fact, exhibit cross-sectional dependency. The Pesaran (2007) and Pesaran (2004) tests both reveal values of 0.388 for the CD tests for PS, but the Pesaran (2007) test only indicates a value of 0.39. Both of these values fall short of the statistical threshold for significance, which indicates that there is no significant correlation between the two cross-sections for the PS variable. A highly significant value of 7.61 was found in the cross-sectional dependence (CD) test for TI that was conducted by Pesaran (2007). This result indicates that there is CD for the TI variable. Nevertheless, the CD test conducted by Pesaran (2004) reports a value of 0.

4.1.3 Heteroskedasticity Test

The Breusch-Pagan and Cook-Weisberg test is applied to a regression model in order to determine whether or not it contains heteroscedasticity. It investigates whether or not the variance of the error term in the model is dependent on the variables that are considered independent. For the purpose of determining whether or not the test was statistically significant, a chi-squared statistic and an associated probability value are generated.

Table 4.3 Heteroskedasticity Test

Test	chi2	Prob > chi2
Breusch–Pagan/Cook–Weisberg test	0.14	0.7073

Note ***, ** & * represents 1%, 5% & 10% significant level

The significance of the chi-squared statistic that was computed by the test is indicated by the value of 0.14 for the test statistic. The probability value (0.7073), which is related to the test statistic, is however the most crucial factor to take into consideration. The level of statistical significance of the test is quantified by using this probability value, which is also referred to as the p-value. The p-value in this scenario is 0.7073, which is considered to be a high value. When evaluating a statistical hypothesis, the 0.05 threshold represents an extensively used common criterion for significance. If the p-value is greater than 0.05, it shows that there is insufficient evidence to reject the null hypothesis of homoscedasticity. This is because the null hypothesis states that the distribution of the samples is homoscedastic. According to this test, the regression model does not show any obvious signs of heteroscedasticity, which means that the test's results are meaningless. Therefore, the Breusch-Pagan/Cook-Weisberg test does not show significant evidence of heteroscedasticity in your regression model based on the findings that were provided. This conclusion is drawn based on the information that was provided.

4.1.4 Slope of Homogeneity Test

The tests for slope homogeneity were conducted in order to investigate the null hypothesis (H0), which states that the slope coefficients are consistent across all of the variables. These tests were based on the methodology described by Blomquist and Westerlund (2013) and Pesaran and Yamagata (2008).

Table 4.4 Slope of Homogeneity

Slope Of Homogeneity		
Test	**T- Statistic**	**P-Value**
Westerlund	32.281***	0.000
Adj Delta	52.714***	0.000
Pesaran	9.986***	0.000
Adj Delta	16.308***	0.000

Note ***, ** & * represents 1%, 5% & 10% significant level

The findings of both tests show convincing evidence against the null hypothesis, indicating large departures from slope homogeneity among the variables. This contradicts the premise that the slopes of the variables are all the same. The Delta coefficient was assessed to be 32.281 (p 0.001) when using the Blomquist and Westerlund test, while the Adjusted Delta coefficient was computed to be 52.714 (p 0.001) during this same test. Similarly, the Delta coefficient was calculated to be 9.986 (p 0.001) in the Pesaran and Yamagata test, and the Adjusted Delta coefficient was determined to be 16.308 (p 0.001) in the same test. These findings reveal that the relationships between the variables display considerable differences in their slope coefficients, which suggests that the impact of one variable on another is not consistent across the entire dataset. This conclusion may be drawn from the fact that the slope coefficients exhibit substantial variances. The analyses demonstrate how important it is to consider these differences and to consider the potential heterogeneity that exists in the interactions by demonstrating that the assumption of slope uniformity is false.

4.1.5 Second Generation Unit Root Test

Second generation unit root tests are used if the data exhibits cross-sectional dependency. Cross sectional dependence Augmented Dicky-fuller (CADF) and cross sectionally Im-pesaran test are the second-generation unit root tests used in this study since the findings of the CD test indicate that there is cross sectional dependency in the data set (CIPS).

Table 4.5 Second Generation Unit Root Test

Variable	CADF		CIPS	
	I (0)	I (1)	I (0)	I (1)
GHGs	-1.523	-3.664***	-1.523	-3.66***
GF	-2.08***	/	-2.663***	/
FI	-1.96***	/	-1.63	-2.77***
FD	-1.210	-2.654***	-0.981	-2.65***
IT	-1.812	-2.441***	-1.870	-3.396***
FDI	-2.53***	/	-2.528***	/
PS	-1.955***	/	-2.348***	/
TI	-1.335	-3.470***	-1.191	-3.470***
NRR	-2.05***	/	-1.812	-3.314***

Note ***, ** & * represents 1%, 5% & 10% significant level

Above table reveals the results of the unit root test. The table shows that GHGs gasses are insignificant at level with the values (-1.523) for CADF and (-1.523) for CIPS and is significant at first difference in both test CADF (-3.664) and CIPS (-3.663) that is means GHGs is stationary at the first difference. The result of the GF shows that it is stationary at level with values (-2.08) for CIPS and (-2.663) CADF. The result of the FI shows that it is stationary at level with values (-1,96) for CADF, but FI is insignificant at level for (-1.63) CIPS and significant at first different at (-2.77). Above results reveal that FD is insignificant at level with the values (-1.210) for CADF and (-0.981) for CIPS and is significant at first difference in both test CADF (-2.654) and CIPS (-

2.65) that is means FD is stationary at the first difference. Above results reveal that IT is insignificant at level with the values (-1.812) for CADF and (-1.870) for CIPS and is significant at first difference in both test CADF (-2.441) and CIPS (-3.396) that is means IT is stationary at the first difference. The result of the FDI shows that it is stationary at level with values (-2.53) for CIPS and (-2.528) CADF. The result of the PS shows that it is stationary at level with values (-1.955) for CIPS and (-2.348) CADF. Above results reveal that TI is insignificant at level with the values (-1.335) for CADF and (-1.191) for CIPS and is significant at first difference in both test CADF (-3.470) and CIPS (-3.470) that is means TI is stationary at the first difference. The result of the NRR shows that it is stationary at level with values (-2.05) for CADF, but FI is insignificant at level for (-1.812) CIPS and significant at first different at (-3.314).

4.1.6 Cointegration Test

In the current analysis, three different cointegration tests—namely, the Westerlund, the Kao, and the Pedroni—were conducted in order to determine whether or not the variables that were being examined exhibited cointegration.

- Westerlund Cointegration Test

The Wester Lund test for cointegration investigates whether or not the variables have been linked together over an extended period of time. To establish the statistical significance of the co-integration connection, the test outputs a test statistic and a matching p-value for each outcome of the test.

Table 4.6 Westerlund Cointegration Test

	Westerlund Cointegration	
	Statistic	p-value
Variance	-2.3511	0.0094

The results of the Westerlund cointegration test showed that there was a statistically significant cointegration relationship between the variables. The test statistic was -2.3511, and the p-value was 0.0094. These data provide credence to the hypothesis that there is an equilibrium among the variables over the long term, so providing evidence for the existence of a meaningful and enduring connection between them.

- Kao Cointegration Test

The Kao cointegration test investigates whether or not the variables have developed a long-term connection, also known as cointegration. In order to evaluate the statistical significance of the cointegration connection, it applies a variety of test statistics, each of which is accompanied by a corresponding p-value. The following is a summary of the findings from the Kao cointegration test about Model variables:

Table 4.7 Kao Cointegration Test

Kao Cointegration Test		
	Statist	**p-value**
Modified. Dickey–Fuller	2.945	0.0016
Dickey–Fuller t	3.8585	0.0001
Augmented. Dickey–Fuller t	3.6369	0.0001
Unadjusted. modified Dickey–Fuller	-0.1061	0.4578
Unadjusted. Dickey-Fuller t	1.0529	0.1462

Note ***, ** & * represents 1%, 5% & 10% significant level

The results of the Kao cointegration test provide convincing evidence that the variables have been linked together over time. The Modified Dickey–Fuller t, Dickey–Fuller t, and Augmented Dickey–Fuller t statistics all produced significant positive values, which indicates that there is a statistically significant cointegration relationship (p-values less than 0.001) between the two variables. However, the Unadjusted modified Dickey–Fuller and Unadjusted Dickey–Fuller t statistics did not demonstrate as convincing evidence for cointegration as the other statistics, as evidenced by their higher p-values. In general, these data provide credence to the hypothesis that there is a significant and enduring link between the many factors that were investigated throughout time.

- Pedroni Cointegration Test

The Pedroni cointegration test is another method that can be used to evaluate whether or not there is a long-term connection or cointegration between the variables being studied. In order to determine the statistical significance of the co-integration connection, it applies a variety of test statistics, each of which is accompanied by a corresponding p-value. The following table presents the findings of the Pedroni test of cointegration for model variables:

Table 4.8 Pedroni Cointegration Test

Pedroni Cointegration		
	Stat	**p-value**
Modified. Phillips–Perron	10.6985	0.000
Phillips–Perron t	-7.1718	0.000
Augmented. Dickey–Fuller	-5.763	0.000

Note ***, ** & * represents 1%, 5% & 10% significant level

The Pedroni cointegration test offers convincing evidence that there is a sustained connection between the variables throughout time. The Modified Phillips–Perron t, Phillips–

Perron t, and Augmented Dickey–Fuller t statistics all demonstrate significant magnitudes and exceptionally low p-values (all of which are less than 0.001), which suggests that there is a highly significant cointegration relationship. These findings provide compelling evidence that there is a significant and stable link that exists through time between the many factors that were investigated.

4.2 Basic Analysis Model 2

4.2.1 VIF & Correlation

Problems with multicollinearity arise when the independent variables are significantly associated with one another.

Table 4.9 VIF & correlation matrix

	VIF	RNEC	GF	FI	FD	IT	FDI	PS	TI	NRR	PG	URB	EG	TO
GF	1.02	0.05	1											
FI	1.06	0.01	0.05	1										
FD	1.99	0.03	0.05	0.05	1									
IT	1.21	-0.25	0.02	-0.05	0.04	1								
FDI	1.46	-0.24	0.08	-0.03	0.44	0.18	1							
PS	1.1	0.08	-0.05	-0.11	0.04	-0.09	-0.05	1						
TI	1.67	-0.08	0.09	-0.13	0.51	0.05	0.40	-0.07	1					
NRR	1.8	-0.49	-0.02	0.03	-0.38	-0.05	-0.15	0.05	-0.33	1				
PG	1.48	-0.30	-0.04	0.00	-0.17	0.10	-0.13	0.07	-0.17	0.50	1			
URB	1.92	-0.50	0.04	-0.03	0.45	0.21	0.38	0.13	0.35	0.13	0.17	1		
EG	1.26	0.00	-0.06	-0.02	-0.28	0.11	-0.06	-0.01	-0.18	0.24	0.28	-0.19	1	
TO	1.22	-0.23	0.04	-0.04	0.09	0.27	0.07	-0.16	0.22	0.00	0.01	0.23	0.08	1

Table 4.9 presents the VIF and correlation matrix for the respective variables of 66 nations from 2004 to 2019.

When the degree of multicollinearity among variables is significant, the standard error of the regression coefficient rises, reducing the statistical reliability of these coefficients.

Nonetheless, the most dependable statistical test for multicollinearity is an analysis of Variance Inflation Factor (VIF) with thresholds below 10 (J. Hair, 2009). To find the link among the dependent and independent variables of a study, the correlation matrix is computed. The following table 4.9 depicts VIF & correlation matrix results..The variance inflation factor (VIF) and correlation matrix findings are shown in Table 4.9. Table 4.9 reveals that the VIF number is less than 2, indicating that there is no multi-collinearity among the independent variables. (GF, FI, FD, IT, FDI, PS). The correlation results show that Green Finance, Financial Inclusion, Financial Development, and Public Spending are positively correlated with RNEC, whereas IT and FDI are negatively correlated, which contradicts our expectations. However, given that our sample nations are technologically diverse, i.e., some are highly technologically advanced while others are technologically underdeveloped in comparison to the rest of the world, the correlation makes sense. As a result, international commerce does not require a technological transfer from the rest of the world to improve the technological element of renewable energy. Furthermore, the renewable energy sector is still in its infancy and does not contribute significantly to international trade.

4.2.2 Cross-sectional Dependency Test

The CD test is used to determine whether or not there is cross-sectional dependency, which means whether or not there is a correlation or interdependence among the observations in the dataset, which may or may not have an impact on the validity of the statistical analysis you are performing. The findings of the tests are summarized in the table that follows. The below table shows the results of the CD test. In the Pesaran (2007) test, the CD tests for GHGs suggest a value of 20.127, whereas in the Pesaran (2004) test, the result is 20.13. These values are not high enough to achieve statistical significance, indicating that there is no substantial cross-sectional dependency for the GHGs variable.

Table 4.10 CD Test

Cross-Sectional. Dependency Test		
Variable	**Pesaran (2007) CD**	**Pesaran (2004) CD**
RNE	20.127***	20.13***
GF	-0.872	-0.87
FI	5.418***	5.42***
FD	20.811***	20.81***
IT	-0.005	-0.09
FDI	18.884***	18.88***
PS	0.388	0.39
TI	7.61***	0
NRR	58.366***	0

Note ***, ** & * represents 1%, 5% & 10% significant level

The results of the CD tests for GF indicate values of -0.872 for the Pesaran (2007) tests and -0.87 for the Pesaran (2004) tests, respectively. In a manner comparable to that of GHGs, the results do not attain statistical significance, which indicates that the GF variable does not exhibit any significant cross-sectional dependency. The results of the CD tests for FI indicate that the numbers 5.418 and 5.42 for the Pesaran (2007) and Pesaran (2004) tests, respectively, are extremely significant. These findings point to the possibility of the existence of a cross-sectional dependency for the FI variable. The CD tests for FD show incredibly significant scores of 20.811 and 20.81 for the Pesaran (2007) and Pesaran (2004) tests, respectively. Both of these tests were conducted by Pesaran. This demonstrates that a cross-sectional dependency exists for the FD variable. The CD tests for information technology exhibit results of -0.005 for the Pesaran (2007) tests and -0.09 for the Pesaran (2004) tests, respectively. Both of these values fall short of the statistical threshold for significance, which indicates that there is no significant correlation between the two cross-sections for the IT variable. The Pesaran (2007) and Pesaran (2004) tests both indicate highly significant values for the CD tests for FDI, with 18.884 and 18.88, respectively. This provides evidence that the FDI variable does, in fact, exhibit cross-sectional dependency. The Pesaran (2007) and Pesaran (2004) tests both reveal values of 0.388 for the CD tests for PS, but the Pesaran (2007) test only indicates a value of 0.39. Both of these values fall short of the statistical threshold for significance, which indicates that there is no significant correlation between the two cross-sections for the PS variable. A highly significant value of 7.61 was found in the cross-sectional dependence (CD) test for TI that was conducted by Pesaran (2007). This result indicates that there is cross-sectional dependency for the TI variable. Nevertheless, the CD test conducted by Pesaran (2004) reports a value of 0.

In short, the results of the cross-sectional dependency tests, in particular the tests that were conducted by Pesaran (2007) and Pesaran (2004), indicate that there is a considerable level of cross-sectional reliance among several variables. Several of the variables, including RNE, FI, FD, FDI, TI, and NRR, have test statistics that are extremely significant (p 0.001), which indicates that there is substantial evidence of cross-sectional dependency. On the other hand, the results for the variables GF, IT, and PS are not statistically significant, which suggests that there is no significant cross-sectional relationship between them.

4.2.3 Heteroskedasticity Test

The Breusch-Pagan and Cook-Weisberg test is applied to a regression model in order to determine whether or not it contains heteroscedasticity. It investigates whether or not the variance of the error term in the model is dependent on the variables that are considered independent. For the purpose of determining whether or not the test was statistically significant, a chi-squared statistic and an associated probability value are generated.

Table 4.11 Heteroskedasticity Test

Test	**chi2**	Prob > chi2
Breusch–Pagan/Cook–Weisberg test	202.21	0.000

The magnitude of the test result, which was 202.21, is represented by the test statistic, and it offers information on the degree to which heteroscedasticity existed. An increased value for the test statistic is indicative of a stronger showing of heteroscedasticity. The test's statistical significance can be deduced from the fact that its p-value is 0.000. A p-value that is lower than the significance level that has been decided upon (for example, 0.05 or 0.01) indicates that the test result is statistically significant and provides evidence to reject the null hypothesis of homoscedasticity. Accordingly, the results of the Breusch-Pagan and Cook-Weisberg tests show that there is statistically substantial evidence of heteroscedasticity in the data. This conclusion is drawn from the outcomes of the study. Because of this, the assumption of homoscedasticity has been broken because the variances of the error components in the regression model are not equal to one another.

4.2.4 Slope of Homogeneity Test

The tests for slope homogeneity were conducted in order to investigate the null hypothesis (H0), which states that the slope coefficients are consistent across all of the variables. These tests were based on the methodology described by Blomquist and Westerlund (2013) and Pesaran and Yamagata (2008).

Table 4.12 Slope of Homogeneity Test

Slope Of Homogeneity		
Test	**T- Statistic**	**P-Value**
Westerlund	15.516***	0.000
Adj delta	25.338***	0.000
Pesaran	8.091***	0.000
Adj delta	13.213***	0.000

Note ***, ** & * represents 1%, 5% & 10% significant level

The findings of the Blomquist and Westerlund test indicated that both the Delta and Adjusted Delta coefficients were highly significant (p 0.001), with values of 15.516 and 25.338, respectively. These findings were based on the fact that these coefficients had the same values. These findings offered considerable evidence that contradicted the null hypothesis of slope homogeneity, demonstrating that slope heterogeneity is present. In a similar vein, the Pesaran and Yamagata test produced significant coefficients for Delta and Adjusted Delta (p 0.001), with corresponding values of 8.091 and 13.213. These findings provided more evidence against the validity of the null hypothesis and pointed to the presence of slope heterogeneity. Both of these tests lead to a better understanding of the slope heterogeneity that exists among the variables by considering the constant variable and using the right statistical procedures. When studying the correlations between the variables, these findings illustrate how important it is to acknowledge variances in the slope coefficients, which adds useful insights to the various fields of study.

4.2.5 Second Generation Unit Root Test

When cross-sectional dependencies are present, second-generation unit root tests are used. Because the cross-sectional dependency in the data set is evident from the results of the CD test, this study uses the cross-sectional dependence Augmented Dicky-fuller (CADF) and cross-sectional Im-pesaran tests as second-generation unit root tests (CIPS).

Table 4.13 Second Generation Unit Root Test

Variable	**CADF**		**CIPS**	
	I (0)	**I (1)**	**I (0)**	**I (1)**
RNE	-1.190	-3.501 ***	-1.190	-3.501 ***
GF	-2.08***	/	-2.663***	/
FI	-1.96***	/	-1.63	-2.77***
FD	-1.210	-2.654***	-0.981	-2.65***
IT	-1.812	-2.441***	-1.870	-3.396***
FDI	-2.53***	/	-2.528***	/
PS	-1.955***	/	-2.348***	/
TI	-1.335	-3.470***	-1.191	-3.470***
NRR	-2.05***	/	-1.812	-3.314

Above table reveals the results of the unit root test. The table shows that GHGs gasses are insignificant at level with the values (-1.190) for CADF and (-1.190) for CIPS and is significant at first difference in both test CADF (-3.501) and CIPS (-3.501) that is means GHGs is stationary at the first difference. The result of the GF shows that it is stationary at level with values (-2.08) for CIPS and (-2.663) CADF. The result of the FI shows that it is stationary at level with values (-1,96) for CADF, but FI is insignificant at level for (-1.63) CIPS and significant at first different at

(-2.77). Above results reveal that FD is insignificant at level with the values (-1.210) for CADF and (-0.981) for CIPS and is significant at first difference in both test CADF (-2.654) and CIPS (-2.65) that is means FD is stationary at the first difference. Above results reveal that IT is insignificant at level with the values (-1.812) for CADF and (-1.870) for CIPS and is significant at first difference in both test CADF (-2.441) and CIPS (-3.396) that is means IT is stationary at the first difference. The result of the FDI shows that it is stationary at level with values (-2.53) for CIPS and (-2.528) CADF. The result of the PS shows that it is stationary at level with values (-1.955) for CIPS and (-2.348) CADF. Above results reveal that TI is insignificant at level with the values (-1.335) for CADF and (-1.191) for CIPS and is significant at first difference in both test CADF (-3.470) and CIPS (-3.470) that is means TI is stationary at the first difference. The result of the NRR shows that it is stationary at level with values (-2.05) for CADF, but FI is insignificant at level for (-1.812) CIPS and significant at first different at (-3.314).

In conclusion, in order to investigate whether or not the variables possessed stationarity characteristics, the CADF and CIPS tests were conducted. According to the findings, variables like RNE, FI, FD, IT, and TI are integrated of order one (I (1)), which suggests that they are not stationary. Variables such as GF, FDI, and PS, on the other hand, appeared to be integrated of order zero (I (0)), which indicates stationarity in the system. There is considerable room for interpretation regarding the stationarity features of the variables FI and NRR since, while the CIPS test suggests that the variables are not stationary, the CADF test does not provide significant support for either the I (0) or the I (1) specifications.

4.2.6 Cointegration Test

In the current analysis, three different cointegration tests—namely, the Westerlund, the Kao, and the Pedroni—were conducted in order to determine whether or not the variables that were being examined exhibited cointegration.

- Westerlund Cointegration Test

The Westerlund test for cointegration investigates whether or not the variables have been linked together over an extended period of time. To establish the statistical significance of the co-integration connection, the test outputs a test statistic and a matching p-value for each outcome of the test.

Table 4.14 Westerlund Cointegration Test

	Westerlund Cointegration	
	Statistic	p-value
Variance	-1.9612	0.0249

The magnitude of the Westerlund test result is indicated by the test statistic of -1.9612, which is negative. The significance of this value represents the weight of the evidence that cointegration exists. In this particular scenario, the negative test statistic points to the prospect of a cointegration relationship. An indicator of the statistical significance of the test is provided by the p-value, which was found to be 0.0249. If the p-value for the test is lower than the significance level that you have set, for example 0.05 or 0.01, this shows that the test result is statistically significant and provides reasonable evidence to reject the null hypothesis that there is no cointegration. The findings, when taken along with the findings of the Westerlund cointegration test, point to the possibility of the existence of a cointegration connection that is statistically significant between the variables. This suggests the existence of a stable equilibrium or relationship between the variables that are the focus of this analysis over the long run.

In short, the results of the Westerlund cointegration test showed that there was a statistically significant cointegration relationship between the variables. The test statistic was -1.9612, and the p-value was 0.0249. These findings imply that there is either an equilibrium or a relationship that exists over the long term between the many factors that were investigated in this study.

- Kao Cointegration Test

The Kao cointegration test investigates whether or not the variables have developed a long-term connection, also known as cointegration. In order to evaluate the statistical significance of the cointegration connection, it applies a variety of test statistics, each of which is accompanied by a corresponding p-value. The following is a summary of the findings from the Kao cointegration test about Model variables:

Table 4.15 Kao Cointegration Test

Kao Cointegration Test		
	Statist	**p-value**
Modified. Dickey–Fuller	3.5816	0.0002
Dickey–Fuller.	3.7187	0.0001
Augmented. Dickey–Fuller	4.5162	0.0000
Unadjusted. modified Dickey–Fuller	1.5376	0.0621
Unadjusted. Dickey–Fuller	1.5813	0.0569

In order to determine whether or not the variables have a connection that lasts across time, a test called the Kao cointegration test was conducted. The findings of the modified Dickey-Fuller test statistics, the Dickey-Fuller test statistics, and the enhanced Dickey-Fuller test statistics were all highly significant, with t-statistics of 3.5816, 3.7187, and 4.5162, respectively (all p-values were less than 0.01). These data give substantial evidence in support of the co-integration among the variables, which suggests the existence of a long-term equilibrium relationship. Despite the fact that the unadjusted modified Dickey-Fuller and unadjusted Dickey-Fuller t-statistics did not approach conventional levels of significance with p-values of 0.0621 and 0.0569, respectively, they nonetheless show the possibility of a cointegration relationship between the two variables. These findings suggest that the variables under investigation will be found to be associated with one another in a state of long-term equilibrium.

- Pedroni cointegration test

The Pedroni cointegration test is another method that can be used to evaluate whether or not there is a long-term connection or cointegration between the variables being studied. In order to determine the statistical significance of the co-integration connection, it applies a variety of test statistics, each of which is accompanied by a corresponding p-value. The following table presents the findings of the Pedroni test of cointegration for model variables:

Table 4.16 Pedroni cointegration test

Pedroni Cointegration		
	Statistic	**p-value**
Modified. Phillips–Perron t	11.0102	0.000
Phillips–Perron t	-3.2049	0.0007
Augmented. Dickey–Fuller t	-3.575	0.0002

The Pedroni cointegration test offers convincing evidence that there is a sustained connection between the variables throughout time. The Modified Phillips–Perron t, Phillips–Perron t, and Augmented Dickey–Fuller t statistics all demonstrate significant magnitudes and exceptionally low p-values (all of which are less than 0.001), which suggests that there is a highly significant cointegration relationship. These findings provide compelling evidence that there is a significant and stable link that exists through time between the many factors that were investigated.

CHAPTER FIVE

SPECIFICATION ANALYSIS

5.1 Regression Analysis Model 1

5.1.1 Linear Regression

The linear regression analysis was conducted to examine the association among greenhouse gas emissions (GHGs) and several independent variables, including GF, FI, FD, International Trade (IT), FDI, Public Spending (PS) and several control variables.

Table 5.1 Linear Regression Model 1

GHGs	Coef.	St. Err.	t-value	p-value	[95% Conf	Interval]	Sig
GF	-.159	.061	-2.59	.01	-.279	-.039	***
FI	.215	.066	3.25	.001	.085	.345	***
FD	.331	.062	5.34	0	.209	.452	***
IT	.657	.067	9.83	0	.526	.788	***
FDI	-.443	.044	-10.09	0	-.529	-.357	***
PS	-.156	.072	-2.18	.029	-.297	-.016	**
TI	.475	.056	8.52	0	.366	.585	***
NRR	-.029	.027	-1.07	.286	-.082	.024	
PG	-.162	.051	-3.21	.001	-.262	-.063	***
URB	.023	.125	0.19	.852	-.221	.268	
TO	-1.173	.088	-13.29	0	-1.347	-1	***
EG	-.116	.068	-1.70	.09	-.25	.018	*
IND	2.363	.126	18.71	0	2.115	2.611	***
Constant	6.289	.685	9.19	0	4.945	7.632	***

Mean dep	11.494	SD dependent var	1.667
R^2	0.466	N	1056
F-test	70.069	Prob > F	0.000
Akaike crit. (AIC)	3440.342	Bayesian crit. (BIC)	3509.813

**** p<.01, ** p<.05, * p<.1*

The coefficient estimates provide insights into the direction and magnitude of the relationships. The coefficient for GF indicates that a decrease of 1 unit in GF is associated with a decrease in GHGs by -0.159 units ($p < 0.01$). Conversely, an increase of 1 unit in is associated with an increase in GHGs by 0.215 units ($p < 0.01$). Similarly, an increase of 1 unit in is associated with an increase in GHGs by 0.331 units ($p < 0.01$). Furthermore, International Trade (IT) shows a positive relationship with GHGs, as an increase of 1 unit in IT corresponds to an increase in GHGs by 0.657 units ($p < 0.01$). Conversely, exhibits a negative relationship with GHGs, where a decrease of 1 unit in FDI is associated with a decrease in GHGs by -0.443 units ($p < 0.01$).

Additionally, Public Spending (PS) demonstrates a negative relationship with GHGs, with a decrease of 1 unit in PS associated with a decrease in GHGs by -0.156 units ($p < 0.05$). TI exhibits a positive relationship, as an increase of 1 unit in TI corresponds to an increase in GHGs by 0.475 units ($p < 0.01$). Regarding the control variables, NRR does not show a significant relationship with GHGs ($p > 0.1$). Other control variables, including (PG, URB, TO, EG), exhibit significant relationships with GHGs ($p < 0.05$).

The overall model has a coefficient of determination (R-squared) of 0.466, indicating that approximately 46.6% of the variability in GHGs can be explained by the included independent variables. The F-test ($F = 70.069$, $p < 0.001$) indicates the statistical significance of the model.

5.1.2 Fully Modified Ordinary Least Square Estimation (FMOLS)

To estimate the relationship between the Green financial indicators and Sustainable Development in our analysis, the FMOLS model was used. In panel data analysis, FMOLS is a robust econometric technique that accounts for prospective endogeneity and serial correlation. The results of the FMOLS estimation for the Model 1 are given in the table below.

Table 5.2 FMOLS Estimation Model 1

FMOLS Estimation (GHGS)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
GF	-0.035097	0.011253	-3.118855	0.001
FI	0.039616	0.013765	2.878096	0.004
FD	0.027387	0.012111	2.261296	0.024
IT	0.072779	0.013292	5.475565	0.000
FDI	-0.037971	0.008285	-4.583164	0.000
PS	-0.007958	0.013673	-0.58197	0.560
IND	0.288671	0.0291	9.919976	0.000
PG	-0.035595	0.010786	-3.300013	0.001
TO	-0.132728	0.020219	-6.564489	0.000
R^2	0.648699	Mean		3.393303
Ad R^2	0.617499	Std		0.244394
S.E. of regression	0.151149	Sum^2		19.80762
Long-run variance	0.034729			

Note ***, ** & * represents 1%, 5% & 10% significant level

The coefficient estimates provide insights into the direction and magnitude of the relationships. The coefficient estimate for GF is -0.035097 with a standard error of 0.011253. This indicates that a 1 unit decrease in GF is associated with a decrease in GHGs by 0.035097 units ($p < 0.01$). Similarly, FI exhibits a positive relationship with GHGs, as the coefficient estimate is 0.039616 with a standard error of 0.013765. This suggests that a 1 unit increase in FI is associated with an increase in GHGs by 0.039616 units ($p < 0.01$). FD also demonstrates a positive relationship, where a 1 unit increase in FD is associated with an increase in GHGs by 0.027387 units ($p < 0.05$). Furthermore, International Trade (IT) shows a positive relationship with GHGs, as the coefficient estimate is 0.072779 with a standard error of 0.013292. This indicates that a 1 unit increase in IT is associated with an increase in GHGs by 0.072779 units ($p < 0.01$). FDI demonstrates a negative relationship, as the coefficient estimate is -0.037971 with a standard error of 0.008285. This implies that a 1 unit decrease in FDI is associated with a decrease in GHGs by 0.037971 units ($p < 0.01$).

Moreover, Public Spending (PS) does not show a significant relationship with GHGs, as the coefficient estimate is -0.007958 with a standard error of 0.013673 ($p > 0.1$). TI exhibits a positive relationship, where a 1 unit increase in TI is associated with an increase in GHGs by 0.052439 units ($p < 0.01$). Industrialization (IND) also demonstrates a positive relationship, as the coefficient estimate is 0.288671 with a standard error of 0.0291. This suggests that a 1 unit increase in IND is associated with an increase in GHGs by 0.288671 units ($p < 0.01$). Among the control variables, Population Growth (PG) exhibits a negative relationship with GHGs, where a 1 unit decrease in PG is associated with a decrease in GHGs by 0.035595 units ($p < 0.01$). Trade Openness (TO) demonstrates a negative relationship as well, with a coefficient estimate of -0.132728 and a standard error of 0.020219. This implies that a 1 unit decrease in TO is associated with a decrease in GHGs by 0.132728 units ($p < 0.01$).

The model's R-squared value of 0.648699 indicates that approximately 64.87% of the variance in GHGs can be explained by the included independent variables. The adjusted R-squared of 0.617499 suggests that the model accounts for the degrees of freedom and penalizes excessive complexity. The standard error of regression is 0.151149, indicating the average distance between the observed values and the predicted values. The sum squared residual is 19.80762, reflecting the sum of the squared differences between the observed values and the predicted values.

5.1.3 Mediation Influence of TI. (FMOLS)

The mediation analysis examined the mediating influence of TI on the connection between the Green Financial Indicators and Greenhouse Gas Emissions (GHGs). To examine the mediating influence of TI, this study follows the transmission mechanism test as it was followed by Zhu et al., (2023). The results provide valuable insights into the intricate connections among these variables. In the table 5.3, first two columns show the coefficient and P-value for the direct influence of Green Financial indicators on GHGs emissions. Columns three and four show the coefficient and P-value for the influence of Green Financial indicators on the mediator TI. Columns five and six show the coefficient and P-value for the indirect influence of Green Financial indicators with mediation of TI on GHGs emissions.

Table 5.3 Mediation Influence of TI

	Model1 Mediation Influence TI					
	GHGs		TI		GHGs	
Variable	Coefficient	Prob	Coefficient	Prob.	Coefficient	Prob.
GF	-0.035097	0.001	-0.091926	0.0598	-0.258889	0.0007
FI	0.039616	0.004	-0.107729	0.0544	0.178421	0.0371
FD	0.027387	0.024	0.230214	0.0000	0.156935	0.0574
IT	0.072779	0.000	-0.217159	0.0001	0.454850	0.0000
FDI	-0.037971	0.000	0.066637	0.0576	-0.351045	0.0000
PS	-0.007958	0.56	-0.166756	0.0040	-0.135504	0.1347
TI					**0.244762**	**0.0008**
R^2	0.642440	Mean		11.50062		
Adj R^2	0.613099	Std		1.663272		
S.E. of regression	1.034577	Sum^2		978.2997		
Long-run variance	1.673451					

Note ***, ** & * represents 1%, 5% & 10% significant level

Analyzing the individual relationships between the Green financial Indicators and GHGs, we found the following results. GF displayed a significant negative relationship with GHGs (β = -0.035097, p = 0.001). This indicates that an increase in GF is associated with a decrease in GHGs. FI exhibited a significant positive relationship with GHGs (β = 0.039616, p = 0.004). Thus, an increase in FI is associated with an increase in GHGs. FD showed a significant positive relationship with GHGs (β = 0.027387, p = 0.024), indicating that an increase in FD is associated with an increase in GHGs. International Trade (IT) demonstrated a significant positive relationship with GHGs (β = 0.072779, p < 0.001). This suggests that an increase in International Trade is associated with an increase in GHGs. FDI showed a significant negative relationship with GHGs (β = -0.037971, $p < 0.001$). Thus, an increase in FDI is associated with a decrease in GHGs. Public Spending (PS) did not exhibit a significant relationship with GHGs (β = -0.007958, p = 0.56).

Moreover, analyzing the relationships between the Green Financial Indicators and TI, the following findings were observed GF displayed a significant negative relationship with TI (β = -0.091926, p = 0.0598). Thus, an increase in GF is associated with a decrease in TI. FI exhibited a significant negative relationship with TI (β = -0.107729, p = 0.0544). This implies that an increase in FI is associated with a decrease in TI. FD demonstrated a significant positive relationship with TI (β = 0.230214, p = 0.000), indicating that an increase in FD is associated with an increase in TI. International Trade (IT) showed a significant negative relationship with TI (β = -0.217159, p = 0.0001). Thus, an increase in International Trade is associated with a decrease in TI. FDI did not exhibit a significant relationship with TI (β = 0.066637, p = 0.0576). Public Spending (PS) displayed a significant negative relationship with TI (β = -0.166756, p = 0.0040). This suggests that an increase in Public Spending is associated with a decrease in TI.

Regarding the mediation influence, the influence of the green financial indicators on the GHGs emissions are improved with the mediation of TI as given the table 5.3 columns five and six. GF displayed a significant negative relationship with GHGs (β = -0.258889, p = 0.0007). These results are improved from the results of that without mediation. TI demonstrated a significant positive mediation influence on the relationship between the Green financial Indicators and GHGs (β = 0.244762, $p < 0.001$). This finding suggests that TI plays a partial mediating role in the relationship between the Green financial Indicators and GHGs emissions.

5.1.4 Mediation Influence of NRR. (FMOLS)

The mediation analysis examined the mediating influence of NRR on the relationship between the Green Financial Indicators and Greenhouse Gas Emissions (GHGs). To examine the mediating influence of NRR, this study follows the transmission mechanism test as it was followed by Zhu et al. (2023). The results provide valuable insights into the intricate connections among these variables. In the table 5.4, first two columns show the coefficient and P-value for the direct influence of Green Financial indicators on GHGs emissions. Columns three and four show the coefficient and P-value for the influence of Green Financial indicators on the mediator NRR. Columns five and six show the coefficient and P-value for the indirect influence of Green Financial indicators with mediation of NRR on GHGs emissions.

Table 5.4 Model 1 Mediation Influence of NRR

Model 1 Mediation influence of NRR						
	GHGs		NRR		GHGs	
Variable	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
GF	-0.035097	0.001	-0.194391	0.0657	-0.024040	0.0227
FI	0.039616	0.004	0.717898	0.0000	0.066112	0.0012
FD	0.027387	0.024	0.330159	0.0030	0.077519	0.0002
IT	0.072779	0	0.584534	0.0000	-0.137501	0.0000
FDI	-0.037971	0	0.127356	0.0898	0.048810	0.0000
PS	-0.007958	0.56	0.460247	0.0003	0.018742	0.4313
NRR					**-0.080119**	**0.0000**
R^2	0.993184	Mean		11.55167		
Adj R^2	0.992640	Std		1.618266		
S.E. of regression	0.138829	Sum^2		17.38471		
Long-run variance	0.033442					

Note ***, ** & * represents 1%, 5% & 10% significant level

First, looking at the relationship between the Green financial Indicators and GHGs emissions, several significant findings emerged. GF demonstrated a significant negative relationship with GHGs emissions (β = -0.035097, p = 0.001), indicating that an increase in GF is associated with a decrease in GHGs emissions. FI exhibited a significant positive relationship with GHGs emissions (β = 0.039616, p = 0.004), suggesting that higher levels of FI are associated with increased GHGs emissions. FD also showed a significant positive relationship with GHGs emissions (β = 0.027387, p = 0.024), indicating that an increase in FD is associated with higher GHGs emissions. International Trade (IT) demonstrated a significant positive relationship with GHGs emissions (β = 0.072779, p < 0.001), suggesting that increased IT is associated with higher GHGs emissions. FDI showed a significant negative relationship with GHGs emissions (β = -0.037971, p < 0.001), indicating that higher levels of FDI are associated with lower GHGs emissions. Public Spending (PS) did not exhibit a significant relationship with GHGs emissions (β = -0.007958, p = 0.56).

Additionally, the analysis focused on the relationship between the Green financial Indicators and NRR. GF demonstrated a significant negative relationship with NRR emissions (β = -0.194391, p = 0.0657), indicating that an increase in GF is associated with a decrease in NRR emissions. FI showed a significant positive relationship with NRR (β = 0.717898, p < 0.001), suggesting that higher levels of FI are associated with increased NRR. FD also displayed a significant positive relationship with NRR (β = 0.330159, p = 0.003), indicating that an increase in FD is associated with higher NRR. International Trade (IT) demonstrated a significant positive relationship with NRR (β = 0.584534, p < 0.001), suggesting that increased IT is associated with higher NRR. FDI shows a significant relationship with NRR (β = 0.127356, p = 0.0898). Public spending (PS) showed a significant positive relationship with NRR (β = 0.460247, p < 0.0003), suggesting that higher levels of PS are associated with increased NRR.

Moreover, the mediation influence of NRR was examined in the relationship between the independent variables and GHGs emissions. The coefficient estimate for NRR in the relationship with GHGs emissions was significant (β = -0.080119, $p < 0.001$), suggesting that NRR plays a mediating role in the relationship between the independent variables and GHGs emissions.

5.1.5 Dynamic Ordinary Least Square Estimation (DOLS)

This study uses the DOLS estimation technique to investigate the relationships between the Green Financial Indicators and Sustainable Development. DOLS is a panel data method that accounts for the presence of endogeneity and serial correlation, yielding accurate estimates of the coefficients. Using the DOLS method, this study shed light on the underlying mechanisms at play by elucidating the long-term dynamics and causal relationships.

Table 5.5 DOLS Estimation

DOLS ESTIMATION (GHGS)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
GF	-0.031383	0.01072	-2.92891	0.003
FI	0.029184	0.0127	2.297839	0.021
FD	0.025397	0.01182	2.148498	0.031
IT	0.06975	0.01254	5.561656	0.000
FDI	-0.036785	0.00783	-4.69891	0.000
PS	-0.019408	0.01302	-1.49037	0.136
TI	0.054241	0.01094	4.96051	0.000
NRR	-0.011573	0.00512	-2.26097	0.024
TO	-0.128658	0.01966	-6.54432	0.000
LL	-0.045345	0.038	-1.19315	0.233
IND	0.287216	0.02777	10.34397	0.000
R^2	0.647255	Mean		3.38135
Adj R^2	0.619871	Std		0.24613
S.E. of regression	0.15175	Sum^2		22.5445
Long-run variance	0.036335			

Note ***, ** & * represents 1%, 5% & 10% significant level

Analyzing the relationships between the independent variables and GHGs, the following results were obtained shown in the above table. GF exhibited a statistically significant negative relationship with GHGs (coefficient = -0.031383, $p = 0.0035$). This suggests that an increase in GF is associated with a decrease in GHGs. FI demonstrated a statistically significant positive relationship with GHGs (coefficient = 0.029184, $p = 0.0218$), indicating that an increase in FI is associated with an increase in GHGs. FD displayed a statistically significant positive relationship with GHGs (coefficient = 0.025397, $p = 0.0319$). This implies that an increase in FD is associated with an increase in GHGs. International Trade (IT) showed a statistically significant positive relationship with GHGs (coefficient = 0.06975, $p < 0.001$), suggesting that an increase in International Trade is associated with an increase in GHGs.

Furthermore, FDI exhibited a statistically significant negative relationship with GHGs (coefficient = -0.036785, $p < 0.001$), indicating that an increase in FDI is associated with a decrease in GHGs. Public Spending (PS) did not show a statistically significant relationship with GHGs (coefficient = -0.019408, $p = 0.1364$). TI demonstrated a statistically significant positive relationship with GHGs (coefficient = 0.054241, $p < 0.001$), indicating that an increase in TI is associated with an increase in GHGs. NRR exhibited a statistically significant negative relationship with GHGs (coefficient = -0.011573, $p = 0.024$), suggesting that an increase in NRR is associated with a decrease in GHGs. Among the control variables Trade Openness (TO) displayed a statistically significant negative relationship with GHGs (coefficient = -0.128658, $p < 0.001$), indicating that an increase in Total Output is associated with a decrease in GHGs. Literacy level (LL) did not show a statistically significant relationship with GHGs (coefficient = -0.045345, $p = 0.2331$). Industrialization (IND) demonstrated a statistically significant positive relationship with GHGs (coefficient = 0.287216, $p < 0.001$), indicating that an increase in Industrialization is associated with an increase in GHGs.

The model's R-squared value of 0.647255 indicates that approximately 64.73% of the variance in GHGs can be explained by the included independent variables. The adjusted R-squared value of 0.619871 suggests that the model adjusts for the degrees of freedom and avoids overfitting. The standard error of regression is 0.15175, representing the average distance between the observed values and the predicted values. The sum squared residual is 22.54452, reflecting the sum of the squared differences between the observed values and the predicted values

5.1.6 Mediation Influence of TI. (DOLS)

The DOLS estimation was conducted to examine the mediation influence of TI on the relationship between greenhouse gas emissions (GHGs) and several independent variables, including GF, FI, FD, International Trade (IT), FDI, and Public Spending (PS). This study follows the transmission mechanism test as it was followed by Zhu et al. (2023). The results provide valuable insights into the intricate connections among these variables. In the table 5.6, first two columns show the coefficient and P-value for the direct influence of Green Financial indicators on GHGs emissions. Columns three and four show the coefficient and P-value for the influence of Green Financial indicators on the mediator TI. Columns five and six show the coefficient and P-value for the indirect influence of Green Financial indicators with mediation of TI on GHGs emissions. The coefficient estimates provide insights into the direction and magnitude of these relationships. GF displays a significant negative relationship with GHGs ($\beta = -0.031383$, $p = 0.0035$), indicating that an increase in GF is associated with a decrease in GHGs. Moreover, GF exhibits a significant positive relationship with TI ($\beta = 2.096464$, $p < 0.001$), suggesting that an increase in GF leads to an increase in TI.

Table 5.6 Model 1 Mediation impact of TI (DOLS)

Model 1 Mediation Influence of TI (DOLS)						
	Dependent GHGs		Dependent TI		Dependent GHGs	
Variable	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
GF	-0.031383	0.0035	2.096464	0.0000	-0.192512	0.0076
FI	0.029184	0.0218	-10.34405	0.0000	0.156981	0.0544
FD	0.025397	0.0319	0.281517	0.0000	0.151371	0.0544
IT	0.06975	0.0000	6.246644	0.0000	0.490191	0.0000
FDI	-0.036785	0.0000	3.534952	0.0013	-0.241941	0.0000
PS	-0.019408	0.1364	4.653652	0.0000	-0.177154	0.0411
TI					**0.390389**	**0.0000**
R^2	0.652902	Mean	11.49402			
Adj R^2	0.626338	Std	1.667481			
S.E. of regression	1.019295	Sum^2	1018.184			
Long-run variance	1.639704					

Note ***, ** & * represents 1%, 5% & 10% significant level

FI shows a significant positive relationship with GHGs (β = 0.029184, p = 0.0218), indicating that an increase in FI is associated with an increase in GHGs. However, FI exhibits a significant negative relationship with TI (β = -10.34405, $p < 0.001$), suggesting that an increase in FI leads to a decrease in TI. FD demonstrates a significant positive relationship with GHGs (β = 0.025397, p = 0.0319), indicating that an increase in FD is associated with an increase in GHGs. Similarly, FD displays a significant positive relationship with TI (β = 0.281517, $p < 0.001$), suggesting that an increase in FD leads to an increase in TI. International Trade (IT) exhibits a significant positive relationship with GHGs (β = 0.06975, $p < 0.001$), indicating that an increase in International Trade is associated with an increase in GHGs. Additionally, IT shows a significant positive relationship with TI (β = 6.246644, $p < 0.001$), suggesting that an increase in International Trade leads to an increase in TI. FDI demonstrates a significant negative relationship with GHGs (β = -0.036785, $p < 0.001$), indicating that an increase in FDI is associated with a decrease in

GHGs. Moreover, FDI exhibits a significant positive relationship with TI ($\beta = 3.534952$, $p = 0.0013$), suggesting that an increase in FDI leads to an increase in TI. Public Spending (PS) does not show a significant relationship with GHGs ($\beta = -0.019408$, $p = 0.1364$). However, PS displays a significant positive relationship with TI ($\beta = 4.653652$, $p < 0.001$), indicating that an increase in Public Spending leads to an increase in TI.

The inclusion of TI in the model reveals its significant positive mediation influence on the relationship between the Green Financial Indicators and GHGs. TI exhibits a significant positive relationship with GHGs ($\beta = 0.390389$, $p < 0.001$), suggesting that an increase in TI is associated with an increase in GHGs.

The model's R-squared value of 0.652902 indicates that approximately 65.29% of the variance in GHGs can be explained by the included independent variables. The adjusted R-squared value of 0.626338 suggests that the model accounts for the degrees of freedom and penalizes excessive complexity. The standard error of regression is 1.019295, reflecting the average distance between the observed values and the predicted values. Additionally, the sum squared residual is 1018.184, representing the sum of the squared differences between the observed values and the predicted values.

5.1.7 Mediation Influence of NRR. (DOLS)

The DOLS estimation was conducted to examine the mediation influence of NRR on the relationship between greenhouse gas emissions (GHGs) and several independent variables, including GF, FI, FD, International Trade (IT), FDI, and Public Spending (PS). This study follows the transmission mechanism test as it was followed by Zhu et al. (2023). The results provide valuable insights into the intricate connections among these variables. In the table 5.4, first two columns show the coefficient and P-value for the direct influence of Green Financial indicators on GHGs emissions. Columns three and four show the coefficient and P-value for the influence of Green Financial indicators on the mediator NRR. Columns five and six show the coefficient and P-value for the indirect influence of Green Financial indicators with mediation of NRR on GHGs emissions.

Table 5.7 Model1 Mediation Influence of NRR (DOLS)

Model 1 Mediation Influence of NRR (DOLS)						
	Dependent GHGs		Dependent NRR		Dependent GHGs	
Variable	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
GF	-0.031383	0.0035	-0.170884	0.0785	-0.234543	0.0014
FI	0.029184	0.0218	0.598788	0.0000	0.182012	0.0340
FD	0.025397	0.0319	0.198885	0.0590	0.251956	0.0011
IT	0.06975	0	0.520103	0.0000	0.458143	0.0000
FDI	-0.036785	0	0.272307	0.0951	-0.232224	0.0000
PS	-0.019408	0.1364	0.424310	0.0003	-0.191690	0.0305
NRR					**-0.084047**	**0.0152**
R^2	0.638484		Mean	11.49402		
Adj R^2	0.611214		Std	1.667481		
S.E. of regression	1.039720		Sum^2	1060.478		
Long-run variance	1.711140					

GF demonstrates a significant negative relationship with GHGs (β = -0.031383, p = 0.0035) and NRR (β = -0.170884, p = 0.0785). This indicates that an increase in GF is associated with a decrease in both GHGs and NRR. FI exhibits a significant positive relationship with GHGs (β = 0.029184, p = 0.0218) and NRR (β = 0.598788, p < 0.001). Thus, an increase in FI is associated with an increase in both GHGs and NRR. FD shows a significant positive relationship with GHGs (β = 0.025397, p = 0.0319) and NRR (β = 0.198885, p = 0.0590). This suggests that an increase in FD is associated with an increase in both GHGs and NRR. International Trade (IT) demonstrates a significant positive relationship with GHGs (β = 0.06975, p < 0.001) and NRR (β = 0.520103, p

< 0.001). This indicates that an increase in International Trade is associated with an increase in both GHGs and NRR. FDI shows a significant negative relationship with GHGs ($\beta = -0.036785$, $p < 0.001$) and a positive relationship with NRR ($\beta = 0.272307$, $p = 0.0951$). Thus, an increase in FDI is associated with a decrease in GHGs and an increase in NRR. Public Spending (PS) does not exhibit a significant relationship with GHGs ($\beta = -0.019408$, $p = 0.1364$) but shows a positive relationship with NRR ($\beta = 0.424310$, $p = 0.0003$). This suggests that an increase in Public Spending is associated with an increase in NRR but does not significantly affect GHGs.

The inclusion of NRR in the model reveals its significant positive mediation influence on the relationship between the Green Financial Indicators and GHGs. NRR exhibits a significant negative relationship with GHGs ($\beta = -0.0840457$, $p < 0.015$), suggesting that an increase in NRR is associated with a decrease in GHGs.

The mean of the dependent variable is 11.49402, representing the average value of NRR across the observations. The adjusted R-squared value of 0.611214 considers the degrees of freedom in the model and penalizes excessive complexity. It is slightly lower than the R-squared value, suggesting that the model's explanatory power may be slightly overestimated when considering the number of variables and sample size. The standard deviation of the dependent variable is 1.667481, indicating the average amount of variability or dispersion in the NRR values around the mean. The standard error of regression (S.E. of regression) is 1.039720, representing the average distance between the observed values of NRR and the predicted values by the model. The sum squared residual is 1060.478, which reflects the sum of the squared differences between the observed NRR values and the predicted values by the model. It is an indicator of the model's goodness of fit, with smaller values indicating a better fit. Lastly the long-run variance is 1.711140, although it is not directly associated with the interpretation of the model's performance. It may represent the estimated long-run volatility or variability of the NRR variable.

5.2 Regressions Analysis Model 2

5.2.1 Linear Regression

The linear regression analysis was conducted to examine the relationship between Renewable Energy Consumption (RNE) and several independent variables, including GF, FI, FD, International Trade (IT), FDI, Public spending (PS), TI, NRR, and several control variables.

Table 5.8 Model 2 Linear Regression

RNE	Coef.	St. Err.	t-value	p-value	[95% Conf	Interval]	Sig
GF	22.969	6.573	3.49	0	10.071	35.866	***
FI	3.115	1.027	3.03	.002	1.1	5.13	***
FD	1.897	.931	2.04	.042	.071	3.724	**
IT	-5.045	.863	-5.85	0	-6.738	-3.351	***
FDI	-.668	.618	-1.08	.28	-1.88	.545	
PS	6.077	1.344	4.52	0	3.439	8.715	***
TI	-3.51	.872	-4.02	0	-5.221	-1.798	***
NRR	-1.529	.374	-4.09	0	-2.264	-.795	***
PG	.902	.771	1.17	.242	-.611	2.416	
EG	2.296	1.028	2.23	.026	.279	4.313	**
LL	10.771	2.882	3.74	0	5.116	16.426	***
Constant	-23.34	12.156	-1.92	.055	-47.193	.512	*

Mean	20.285	Std	20.246
R^2	0.109	N	1056
F-test	11.669	Prob > F	0.000
Akaike crit. (AIC)	9250.144	Bayesian crit. (BIC)	9309.691

**** p<.01, ** p<.05, * p<.1*

The coefficient estimates provide insights into the direction and magnitude of the relationships. The coefficient estimate for GF is 22.969 with a standard error of 6.573. This suggests that a 1 unit increase in GF is associated with an increase in RNE by 22.969 units (p <

0.01). Similarly, FI exhibits a positive relationship with RNE, where a 1 unit increase in FI is associated with an increase in RNE by 3.115 units ($p < 0.01$). FD also demonstrates a positive relationship, as a 1 unit increase in FD is associated with an increase in RNE by 1.897 units ($p < 0.05$). Furthermore, International Trade (IT) shows a negative relationship with RNE, with a coefficient estimate of -5.045 and a standard error of 0.863. This suggests that a 1 unit increase in IT corresponds to a decrease in RNE by 5.045 units ($p < 0.01$). The coefficient estimate for FDI is not statistically significant ($p > 0.1$), indicating that there is no significant relationship between FDI and RNE.

Moreover, Public Spending (PS) exhibits a positive relationship with RNE, as the coefficient estimate is 6.077 with a standard error of 1.344 ($p < 0.01$). TI demonstrates a negative relationship, where a 1 unit increase in TI corresponds to a decrease in RNE by 3.51 units ($p < 0.01$). NRR also shows a negative relationship, with a coefficient estimate of -1.529 and a standard error of 0.374 ($p < 0.01$). Amongst the control variables, only Environmental Governance (EG) demonstrates a statistically significant positive relationship with RNE, with a coefficient estimate of 2.296 and a standard error of 1.028 ($p < 0.05$). Public Governance (PG) does not show a significant relationship with RNE ($p > 0.1$). The model's R-squared value of 0.109 indicates that approximately 10.9% of the variance in RNE can be explained by the included independent variables. The F-test ($F = 11.669$, $p < 0.001$) confirms the overall significance of the model

5.2.2 Fully Modified Ordinary Least Square Estimation (FMOLS)

To estimate the relationship between the Green financial indicators and Renewable Energy Consumption in our analysis, the Fully Modified Ordinary Least Squares (FMOLS) model was used. In panel data analysis, FMOLS is a robust econometric technique that accounts for prospective endogeneity and serial correlation. The results of the FMOLS estimation for the Model 2 are given in the table below.

Table 5.9 Model 2 FMOLS Estimation

FMOLS Estimation (RNE)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
GF	1.033859	0.54835	1.885414	0.05
FI	-0.212099	0.08004	-2.65009	0.008
FD	0.385642	0.06966	5.536135	0.000
IT	0.392623	0.16203	2.423228	0.015
FDI	-0.22566	0.04927	-4.58046	0.000
PS	0.250283	0.14956	1.673413	0.094
NRR	-0.222331	0.02897	-7.67444	0.000
PG	0.037421	0.06583	0.568444	0.569
TO	-0.112568	0.11518	-0.97735	0.328
R^2	0.452177	Mean		2.54921
Adj R^2	0.404066	Std		1.17185
S.E. of regression	0.904629	Sum^2		698.874
Long-run variance	1.314182			

Note ***, ** & * represents 1%, 5% & 10% significant level

Among the independent variables, GF exhibits a coefficient estimate of 1.033859, suggesting a positive relationship with RNE. However, the associated p-value of 0.0597 indicates that the relationship is statistically significant at the conventional significance level of 10%. FI demonstrates a coefficient estimate of -0.212099, indicating a negative relationship with RNE. The statistically significant p-value of 0.0082 suggests that higher levels of FI are associated with a decrease in RNE. FD shows a coefficient estimate of 0.385642, implying a positive relationship with RNE. The associated p-value of 0.00 indicates that the relationship is statistically significant.

Similarly, International Trade (IT) exhibits a coefficient estimate of 0.392623, indicating a positive relationship with RNE. The associated p-value of 0.0156 suggests that higher levels of International Trade are associated with an increase in RNE. FDI demonstrates a coefficient estimate of -0.22566. The associated p-value of 0.00 indicates a statistically significant negative relationship between FDI and RNE. Public Spending (PS) exhibits a coefficient estimate of 0.250283, suggesting a positive relationship with RNE. However, the associated p-value of 0.0946 indicates that the relationship is statistically significant at the conventional significance level of 10%. NRR shows a coefficient estimate of -0.222331, indicating a negative relationship with RNE. The associated p-value of 0.00 suggests that higher levels of NRR are associated with a decrease in RNE.

Among the control variables Population Growth (PG) demonstrates a coefficient estimate of 0.037421, suggesting a positive relationship with RNE. The associated p-value of 0.5699 indicates that the relationship is not statistically significant at the conventional significance level of 0.05. Trade openness (TO) shows a coefficient estimate of -0.112568, indicating a negative relationship with RNE. However, the associated p-value of 0.3287 suggests that the relationship is not statistically significant at the conventional significance level of 0.05.

The model's R-squared value of 0.452177 indicates that approximately 45.22% of the variance in RNE can be explained by the included independent variables. The adjusted R-squared value of 0.404066 accounts for the degrees of freedom, indicating that the model adjusts for the complexity of the data. The standard error of regression is 0.904629, reflecting the average distance between the observed values and the predicted values. The sum squared residual of 698.8744 represents the sum of the squared differences between the observed values and the predicted values.

5.2.3 Mediation Influence of TI. (FMOLS)

The mediation analysis examined the mediating influence of TI on the relationship between the Green Financial Indicators and Renewable Energy consumption (RNE). To examine the mediating influence of TI, this study follows the transmission mechanism test as it was followed by Zhu et al. (2023). The results provide valuable insights into the intricate connections among these variables. In the table 5.10, first two columns show the coefficient and P-value for the direct influence of Green Financial indicators on RNE Consumption. Columns three and four show the coefficient and P-value for the influence of Green Financial indicators on the mediator TI. Columns five and six show the coefficient and P-value for the indirect influence of Green Financial indicators with mediation of TI on RNE Consumption.

Table 5.10 Model 2 Mediation of TI (FMOLS)

Model 2 Mediation of TI (FMOLS)						
	Dependent RNE		Dependent TI		Dependent RNE	
Variable	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
GF	1.033859	0.0597	-0.091926	0.0598	0.937813	0.0022
FI	-0.212099	0.0082	-0.107729	0.0544	-2.620897	0.0000
FD	0.385642	0.000	0.230214	0.0000	-2.161539	0.0003
IT	0.392623	0.0156	-0.217159	0.0001	0.014735	0.0296
FDI	-0.22566	0.000	0.066637	0.0576	-1.259007	0.0000
PS	0.250283	0.0946	-0.166756	0.0040	0.522757	0.4372
TI					**-1.322933**	**0.0005**
R^2	0.970407	Mean		19.87199		
Adj R^2	0.968045	Std		19.87531		
S.E. of regression	3.552887	Sum^2		11385.95		
Long-run variance	27.86220					

Note ***, ** & * represents 1%, 5% & 10% significant level

First, analyzing the relationship between the independent variables and RNE, several significant findings emerged. GF demonstrated a marginally significant positive relationship with RNE (β = 1.033859, p = 0.0597), suggesting that an increase in GF may be associated with an increase in RNE. FI exhibited a significant negative relationship with RNE (β = -0.212099, p = 0.0082), indicating that higher levels of FI are associated with a decrease in RNE. FD showed a significant positive relationship with RNE (β = 0.385642, p < 0.001), suggesting that an increase in FD is associated with an increase in RNE. International Trade (IT) demonstrated a significant positive relationship with RNE ($\beta = 0.392623$, $p = 0.0156$), indicating that increased IT is associated with higher RNE. FDI showed a significant negative relationship with RNE ($\beta = -0.22566$, $p < 0.001$), suggesting that higher levels of FDI are associated with a decrease in RNE. Public Spending (PS) did not exhibit a significant relationship with RNE ($\beta = 0.250283$, $p = 0.0946$).

Additionally, the analysis focused on the relationship between the independent variables and TI. GF displayed a marginally significant negative relationship with TI ($\beta = -0.091926$, $p = 0.0598$), suggesting that an increase in GF may be associated with a decrease in TI. FI exhibited a significant negative relationship with TI ($\beta = -0.107729$, $p = 0.0544$), indicating that higher levels of FI are associated with a decrease in TI. FD demonstrated a significant positive relationship with TI ($\beta = 0.230214$, $p < 0.001$), suggesting that an increase in FD is associated with an increase in TI. International Trade (IT) showed a significant negative relationship with TI ($\beta = -0.217159$, $p < 0.0001$), indicating that increased IT is associated with a decrease in TI. FDI did not exhibit a significant relationship with TI ($\beta = 0.066637$, $p = 0.0576$). Public Spending (PS) displayed a significant negative relationship with TI ($\beta = -0.166756$, $p = 0.004$), suggesting that an increase in PS is associated with a decrease in TI.

Moreover, the mediation influence of TI was examined in the relationship between the independent variables and RNE. The coefficient estimate for TI in the relationship with RNE was significant ($\beta = -1.322933$, $p = 0.0005$), indicating that TI plays a mediating role in the relationship between the independent variables and RNE

5.2.4 Mediation Influence of NRR. (FMOLS)

The mediation analysis examined the mediating influence of NRR on the relationship between the Green Financial Indicators and Renewable Energy consumption (RNE). To examine the mediating influence of NRR, this study follows the transmission mechanism test as it was followed by Zhu et al. (2023). The results provide valuable insights into the intricate connections among these variables. In the table 5.11, first two columns show the coefficient and P-value for the direct influence of Green Financial indicators on Renewable Energy consumption (RNE). Columns three and four show the coefficient and P-value for the influence of Green Financial indicators on the mediator NRR. Columns five and six show the coefficient and P-value for the indirect influence of Green Financial indicators with mediation of NRR on Renewable Energy consumption (RNE).

Table 5.11 Model 2 Mediation of NRR (FMOLS)

	Model 2 Mediation of NRR (FMOLS)					
	Dependent RNE		Dependent NRR		Dependent RNE	
Variable	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
GF	1.033859	0.0597	-0.194391	0.0657	0.941642	0.0016
FI	-0.212099	0.0082	0.717898	0.0000	-1.943410	0.0009
FD	0.385642	0	0.330159	0.0030	-1.581654	0.0082
IT	0.392623	0.0156	0.584534	0.0000	0.014981	0.0235
FDI	-0.22566	0	0.127356	0.0898	-1.246156	0.0000
PS	0.250283	0.0946	0.460247	0.0003	0.171348	0.8009
NRR					**0.138886**	**0.0170**
R^2	0.969781	Mean		20.62031		
Adj R^2	0.967333	Std		20.18265		
S.E. of regression	3.647842	Sum^2		11989.38		
Long-run variance	26.57652					

Note ***, ** & * represents 1%, 5% & 10% significant level

First, analyzing the relationship between the independent variables and RNE, several significant findings emerged. GF displayed a marginally significant positive relationship with

RNE (β = 1.033859, p = 0.0597), indicating that an increase in GF may be associated with an increase in RNE. FI exhibited a significant negative relationship with RNE (β = -0.212099, p = 0.0082), suggesting that higher levels of FI are associated with a decrease in RNE. FD showed a significant positive relationship with RNE (β = 0.385642, $p < 0.001$), indicating that an increase in FD is associated with an increase in RNE. International Trade (IT) demonstrated a significant positive relationship with RNE (β = 0.392623, p = 0.0156), suggesting that increased IT is associated with higher RNE. FDI showed a significant negative relationship with RNE (β = -0.22566, $p < 0.001$), indicating that higher levels of FDI are associated with a decrease in RNE. Public Spending (PS) did not exhibit a significant relationship with RNE (β = 0.250283, p = 0.0946).

Additionally, the analysis focused on the relationship between the independent variables and NRR. GF displayed a marginally significant negative relationship with NRR (β = -0.194391, p = 0.0657), suggesting that an increase in GF may be associated with a decrease in NRR. FI exhibited a significant positive relationship with NRR (β = 0.717898, $p < 0.001$), indicating that higher levels of FI are associated with an increase in NRR. FD demonstrated a significant positive relationship with NRR (β = 0.330159, p = 0.003), suggesting that an increase in FD is associated with an increase in NRR. International Trade (IT) showed a significant positive relationship with NRR (β = 0.584534, $p < 0.001$), indicating that increased IT is associated with higher NRR. FDI did not exhibit a significant relationship with NRR (β = 0.127356, p = 0.0898). Public Spending (PS) displayed a significant positive relationship with NRR (β = 0.460247, p = 0.0003), suggesting that an increase in PS is associated with an increase in NRR.

Moreover, the analysis examined the mediation influence of NRR on the relationship between the independent variables and RNE. The coefficient estimate for NRR in the relationship with RNE was significant (β = 0.138886, p = 0.0170), indicating that NRR plays a mediating role in the relationship between the independent variables and RNE

5.2.5 Dynamic Ordinary Least Square Estimation (DOLS)

This study uses the Dynamic Ordinary Least Squares (DOLS) estimation technique to investigate the relationships between the Green Financial Indicators and Renewable energy Consumption. DOLS is a panel data method that accounts for the presence of endogeneity and serial correlation, yielding accurate estimates of the coefficients. Using the DOLS method, this study shed light on the underlying mechanisms at play by elucidating the long-term dynamics and causal relationships.

Table 5.12 Model 2 DOLS Estimation

DOLS Estimation (RNE)					
Variable	Coefficient		Std. Error	t-Statistic	Prob.
GF	0.586043		0.29425	1.991652	0.0467
FI	-2.03272		0.577381	-3.52058	0.0005
FD	-1.65182		0.587274	-2.81269	0.005
FDI	-0.679494		0.199475	-3.40642	0.0007
IT	0.012212		0.006578	1.856465	0.0637
PS	0.204804		0.677437	0.302321	0.7625
LL	-3.294398		2.220781	-1.48344	0.1383
TO	2.932891		1.278888	2.293314	0.022
URB	-0.160139		0.101892	-1.57166	0.1164
EG	-0.056572		0.048337	-1.17038	0.2421
IND	-11.3364		2.036959	-5.56536	0.000
R^2	0.968859	Mean			20.2855
Adj R^2	0.966408	Std			20.2459
S.E. of regression	3.710712	Sum^2			13466.5
Long-run variance	28.43808				

Note ***, ** & * represents 1%, 5% & 10% significant level

GF exhibits a coefficient estimate of 0.586043 with a standard error of 0.29425, suggesting a positive relationship with RNE. The t-statistic of 1.991652 indicates that the relationship is marginally significant at a significant level of 0.05 ($p = 0.0467$). FI demonstrates a coefficient estimate of -2.03272 with a standard error of 0.577381, implying a negative relationship with RNE. The t-statistic of -3.520584 suggests that the relationship is statistically significant at a significant level of 0.01 ($p = 0.0005$), indicating that an increase in FI is associated with a decrease in RNE. FD exhibits a coefficient estimate of -1.65182 with a standard error of 0.587274, indicating a negative relationship with RNE. The t-statistic of -2.812691 suggests that the relationship is statistically significant at a significant level of 0.01 ($p = 0.005$), suggesting that an increase in FD is associated with a decrease in RNE.

Moreover, International Trade (IT) shows a coefficient estimate of 0.012212 with a standard error of 0.006578, suggesting a positive relationship with RNE. The t-statistic of 1.856465 suggests that the relationship is not statistically significant at the conventional significance level of 0.05 ($p = 0.0637$). FDI demonstrates a coefficient estimate of -0.679494 with a standard error of 0.199475, implying a negative relationship with RNE. The t-statistic of -3.406419 indicates that the relationship is statistically significant at a significant level of 0.01 ($p = 0.0007$), suggesting that an increase in FDI is associated with a decrease in RNE. The coefficient estimate for PS is 0.204804 with a standard error of 0.677437. The t-statistic of 0.302321 indicates that the relationship is not statistically significant at the conventional significance level of 0.05 ($p = 0.7625$). Therefore, there is no convincing evidence to suggest a significant relationship between PS and RNE in this analysis.

The model's R-squared value of 0.968859 indicates that approximately 96.9% of the variance in RNE can be explained by the included independent variables. The adjusted R-squared value of 0.966408 accounts for the complexity of the model, suggesting a robust fit. The standard error of regression is 3.710712, reflecting the average distance between the observed values and the predicted values. The sum squared residual of 13466.46 represents the sum of the squared differences between the observed values and the predicted values.

5.2.6 Mediation Influence of TI. (FMOLS)

The mediation analysis examined the mediating influence of TI on the relationship between the Green Financial Indicators and Renewable Energy consumption (RNE). To examine the mediating influence of TI, this study follows the transmission mechanism test as it was followed by Zhu et al. (2023). The results provide valuable insights into the intricate connections among these variables. In the table 5.13, first two columns show the coefficient and P-value for the direct influence of Green Financial indicators on RNE Consumption. Columns three and four show the coefficient and P-value for the influence of Green Financial indicators on the mediator TI. Columns five and six show the coefficient and P-value for the indirect influence of Green Financial indicators with mediation of TI on RNE Consumption. The coefficient estimates provide insights into the relationships between the variables. GF displays a significant positive relationship with RNE ($\beta = 1.033859$, $p = 0.0597$), indicating that there is insufficient evidence to conclude that an increase in GF leads to an increase in RNE. However, GF shows a significant positive relationship with TI ($\beta = 2.096464$, $p < 0.0001$), suggesting that an increase in GF is associated with an increase in TI. This implies that GF may indirectly influence RNE through its influence on TI. The coefficient estimates for the mediation influence of TI on the relationship between GF and RNE is 0.604709 ($p = 0.0464$), indicating a partial mediating role of TI in this relationship. FI exhibits a significant negative relationship with RNE ($\beta = -0.212099$, $p = 0.0082$), indicating that an increase in FI is associated with a decrease in RNE. FI also shows a significant negative relationship with TI ($\beta = -10.34405$, $p < 0.0001$), suggesting that an increase in FI is associated with a decrease in TI.

Table 5.13 Model 2 Mediation Influence of TI (DOLS)

	Model 2 Mediation Influence of TI (DOLS)					
	Dependent RNE		Dependent TI		Dependent RNE	
Variable	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
GF	1.033859	0.0597	2.096464	0.0000	0.604709	0.0464
FI	-0.212099	0.0082	-10.34405	0.0000	-2.396047	0.0000
FD	0.385642	0.000	0.281517	0.0000	-1.913463	0.0013
IT	0.392623	0.0156	6.246644	0.0000	0.011462	0.0919
FDI	-0.22566	0.000	3.534952	0.0013	-0.838002	0.0000
PS	0.250283	0.0946	4.653652	0.0000	6.128648	0.3690
TI					**-0.865205**	**0.0263**
R^2	0.966810	Mean		20.28547		
Adj R^2	0.964270	Std		20.24592		
S.E. of regression	3.826959	Sum^2		14352.71		
Long-run variance	30.37105					

Note ***, ** & * represents 1%, 5% & 10% significant level

The coefficient estimates for the mediation influence of TI on the relationship between FI and RNE is -2.396047 ($p < 0.0001$), indicating a substantial mediating role of TI in this relationship. FD demonstrates a significant positive relationship with RNE ($\beta = 0.385642$, $p < 0.0001$) and a positive relationship with TI ($\beta = 0.281517$, $p < 0.0001$). This suggests that an increase in FD is associated with an increase in both RNE and TI. The coefficient estimates for the mediation influence of TI on the relationship between FD and RNE is -1.913463 ($p = 0.0013$), indicating a substantial mediating role of TI in this relationship. International Trade (IT) shows a significant positive relationship with RNE ($\beta = 0.392623$, $p = 0.0156$) and a positive relationship with TI ($\beta = 6.246644$, $p < 0.0001$). This implies that an increase in IT is associated with an increase in both RNE and TI. The coefficient estimates for the mediation influence of TI on the relationship between IT and RNE is 0.011462 ($p = 0.0919$), suggesting a potential statistically significant. mediating role of TI in this relationship. FDI exhibits a significant negative relationship with RNE ($\beta = -0.22566$, $p < 0.0001$) and a positive relationship with TI ($\beta = 3.534952$, p =

0.0013). This indicates that an increase in FDI is associated with a decrease in RNE and an increase in TI. The coefficient estimates for the mediation influence of TI on the relationship between FDI and RNE is -0.838002 ($p < 0.0001$), indicating a substantial mediating role of TI in this relationship. Public Spending (PS) does not show a significant relationship with RNE (β = -0.22566, p = 0.0000) or with TI (β = 4.653652, p = 0.0000). The coefficient estimates for the mediation influence of TI on the relationship between PS and RNE is 6.128648 (p = 0.3690), suggesting no significant mediating role of TI in this relationship.

The model's R-squared value of 0.966810 indicates that approximately 96.68% of the variance in RNE can be explained by the included independent variables. The adjusted R-squared of 0.964270 suggests that the model accounts for the degrees of freedom and provides a good fit to the data. The standard error of regression is 3.826959, representing the average distance between the observed values and the predicted values. The sum squared residual is 14352.71, reflecting the sum of the squared differences between the observed values and the predicted values.

5.2.7 Mediation Influence of NRR. (FMOLS)

The mediation analysis examined the mediating influence of NRR on the relationship between the Green Financial Indicators and Renewable Energy consumption (RNE). To examine the mediating influence of NRR, this study follows the transmission mechanism test as it was followed by Zhu et al. (2023). The results provide valuable insights into the intricate connections among these variables. In the table 5.14, first two columns show the coefficient and P-value for the direct influence of Green Financial indicators on Renewable Energy consumption (RNE). Columns three and four show the coefficient and P-value for the influence of Green Financial indicators on the mediator NRR. Columns five and six show the coefficient and P-value for the indirect influence of Green Financial indicators with mediation of NRR on Renewable Energy consumption (RNE).

Table 5.14 Model 2 Mediation Influence of NRR (DOLS)

	Model 2 Mediation Influence of NRR (DOLS)					
	Dependent RNE		Dependent NRR		Dependent RNE	
Variable	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
GF	1.033859	0.0597.	-0.170884	0.0785	0.058964	0.0651
FI	-0.212099	0.0082	0.598788	0.0000	-0.240458	0.0002
FD	0.385642	0.000	0.198885	0.0590	-0.135947	0.0318
IT	0.392623	0.0156	0.520103	0.0000	-0.042706	0.0513
FDI	-0.22566	0.000	0.272307	0.0951	-0.085320	0.0001
PS	0.250283	0.0946	0.424310	0.0003	0.028934	0.6972
NRR					**0.015605**	**0.0215**
R^2	0.970436		Mean	3.896647		
Adj R^2	0.968108		Std	2.259747		
S.E. of regression	0.403551		Sum^2	159.2709		
Long-run variance	0.336227					

Note ***, ** & * represents 1%, 5% & 10% significant level

The coefficient estimates provide insights into the relationships between the variables. GF shows a significant relationship with RNE (β = -0.170884, p = 0.0785) but has a positive relationship with NRR (β = 0.058964, p = 0.0651). This suggests that GF may have a limited direct influence on RNE but could potentially influence NRR. However, the influence sizes are small, and the significance is marginal. FI exhibits a significant positive relationship with both RNE (β = 1.033859, p = 0.0597) and NRR (β = 0.598788, p < 0.0001). This implies that an increase in FI is associated with an increase in both RNE and NRR. FD demonstrates a significant negative relationship with RNE (β = -0.212099, p = 0.0082) and a positive relationship with NRR (β = 0.198885, p = 0.0590). This suggests that an increase in FD is associated with a decrease in RNE and an increase in NRR. International Trade (IT) shows a significant positive relationship with both RNE (β = 0.385642, p < 0.0001) and NRR (β = 0.520103, p < 0.0001), indicating that an increase in IT is associated with increases in both RNE and NRR. FDI exhibits a significant positive relationship with both RNE (β = 0.392623, p = 0.0156) and NRR (β = 0.272307, p = 0.0951). This suggests that an increase in FDI is associated with increases in both RNE and NRR. Public Spending (PS) does not show a significant relationship with RNE (β = -0.22566, p = 0.0000) or NRR (β = 0.424310, p = 0.0003). This indicates that PS does not have a direct influence on either RNE or NRR.

Regarding the mediation influence of TI, the coefficient estimate for TI is -0.042706 (p = 0.0513) for RNE, suggesting a potential mediating role, although it is not statistically significant. For NRR, the coefficient estimate for TI is 0.015605 (p = 0.0215), indicating a significant positive mediation influence.

The model's R-squared value of 0.970436 for RNE and 0.968108 for NRR indicates that approximately 97.04% and 96.81% of the variance in RNE and NRR, respectively, can be explained by the included independent variables. The adjusted R-squared values of 0.968108 for RNE and 0.968108 for NRR suggest that the models adequately account for the degrees of freedom and provide a good fit to the data. The standard error of regression is 0.403551, representing the average distance between the observed values and the predicted values. The sum squared residual is 159.2709, reflecting the sum of the squared differences between the observed values and the predicted values.

5.3 Granger Causality Test

5.3.1 Granger Causality Test Model 1

The Granger causality test results provide valuable insights into the causal relationships between the variables examined in Model 1. The Granger causality test provides considerable evidence that GF has a causal effect on GHGS. This implies that changes in GF can be attributed to variations in GHGS. While the results indicate that GHGS does not significantly Granger cause GF. This suggests that changes in GHGS do not lead to substantial variations in GF.

Table 5.15 Granger Causality Test Model 1

Granger Causality Test Model 1		
Null Hypothesis:	F-Statistic	Prob.
GF Causes GHGS	2.91871	0.0879
GHGS Causes GF	0.79395	0.3731
FI Causes GHGS	4.27556	0.038
GHGS Causes FI	0.73057	0.393
FD Causes GHGS	3.23943	0.072
GHGS Causes FD	1.85788	0.173
IT Causes GHGS	7.17712	0.008
GHGS Causes IT	2.70237	0.101
FDI Causes GHGS	4.69813	0.031
GHGS Causes FDI	2.50665	0.113
PS Causes GHGS	3.54275	0.06
GHGS Causes PS	0.34743	0.555

Note ***, ** & * represents 1%, 5% & 10% significant level

The Granger causality test provides considerable evidence at the 10% significance level that FI has a causal effect on GHGS. This implies that changes in FI can be attributed to variations in GHGS. On the other hand, the results indicate that GHGS does not significantly Granger cause FI. This suggests that changes in GHGS do not lead to substantial variations in FI. Based on the test results, the Granger causality test provides considerable evidence at the 10% significance level to support the claim that FD has a causal effect on GHGS. Changes in FD are likely to be the driving force behind variations in GHGS. While the results suggest that GHGS does not significantly Granger cause FD at the 10% significance level. This implies that changes in GHGS do not have a substantial influence on FD.

The Granger causality test provides considerable evidence to suggest that IT has a causal effect on GHGS. Changes in IT are likely to contribute to variations in GHGS. At the 10% significance level, we cannot establish a significant causal relationship between GHGS and IT. Changes in GHGS are not found to be influential in explaining variations in IT. The test results indicate considerable evidence that FDI has a causal effect on GHGS. Changes in FDI can be attributed to variations in GHGS. Based on the results, the study finds no significant evidence at the 10% significance level to support the claim that GHGS has a causal effect on FDI. Changes in GHGS are not likely to be the driving force behind variations in FDI. The Granger causality test provides considerable evidence at the 10% significance level to suggest a causal relationship between PS and GHGS. Changes in PS are found to have a significant effect on variations in GHGS. Based on the results, the study finds no significant evidence at the 10% significance level to support the claim that GHGS has a causal effect on PS. Changes in GHGS are not likely to be the driving force behind variations in PS.

5.3.2 Granger Causality Test Model 2

The Granger causality test results provide valuable insights into the causal relationships between the variables examined in Model 2. The Granger causality test provides considerable evidence that GF has a causal effect on RNE. This implies that changes in GF can be attributed to variations in RNE. While the results indicate that RNE does not significantly Granger cause GF. This suggests that changes in RNE do not lead to substantial variations in GF. The Granger causality test provides considerable evidence at the 10% significance level that FI has a causal effect on RNE. This implies that changes in FI can be attributed to variations in RNE. On the other hand, the results indicate that RNE does not significantly Granger cause FI. This suggests that changes in RNE do not lead to substantial variations in FI. Based on the test results, the Granger causality test provides considerable evidence to support the claim that FD has a causal effect on RNE. Changes in FD are likely to be the driving force behind variations in RNE. While the results suggest that RNE does not significantly Granger cause FD at the 10% significance level. This implies that changes in RNE do not have a substantial influence on FD.

Table 5.16 Granger Causality Test Model 2

Granger Causality Test Model 2		
Null Hypothesis:	F-Statistic	Prob.
GF Causes RNE	4.601	0.032
RNE Causes GF	0.53398	0.465
FI Causes RNE	2.73963	0.098
RNE Causes FI	0.46174	0.497
FD Causes RNE	11.0238	0.000
RNE Causes FD	1.15389	0.283
IT Causes RNE	3.13689	0.077
RNE Causes IT	1.11826	0.29
FDI Causes RNE	3.8461	0.05
RNE Causes FDI	0.87076	0.351
PS Causes RNE	3.72353	0.054
RNE Causes PS	0.6154	0.432

Note ***, ** & * represents 1%, 5% & 10% significant level

The Granger causality test provides considerable evidence at 10% significant level to suggest that IT has a causal effect on RNE. Changes in IT are likely to contribute to variations in RNE. At the 10% significance level, we cannot establish a significant causal relationship between RNE and IT. Changes in RNE are not found to be influential in explaining variations in IT. The test results indicate considerable evidence at 10% significant level to suggest that FDI has a causal effect on RNE. Changes in FDI can be attributed to variations in RNE. Based on the results, the study finds no significant evidence at the 10% significance level to support the claim that RNE has a causal effect on FDI. Changes in RNE are not likely to be the driving force behind variations in FDI. The Granger causality test provides considerable evidence at the 10% significance level to suggest a causal relationship between PS and RNE. Changes in PS are found to have a significant effect on variations in RNE. Based on the results, the study finds no significant evidence at the 10% significance level to support the claim that RNE has a causal effect on PS. Changes in RNE are not likely to be the driving force behind variations in PS.

5.4 Robustness Check Model 1

This study uses three regression model D-GMM, Fixed Influence and Random influence model to check the robustness of the results as these were use before for the robustness check by the studies conducted by C. Liu et al. (2023), Osabuohien-Irabor & Drapkin, (2023). The purpose of conducting robustness checks is to verify the consistency and reliability of the results obtained from your primary analysis. The D-GMM method can help to alleviate endogeneity and cross-section dependence issues (Dou et al., 2021). Standard econometric techniques (RE and FE estimators for static panel data estimation and the D-GMM method for dynamic panel data estimation; outcomes provided in sections (1) through (4) of this study are also used to guarantee the validity of the findings D-GMM model results are shown in column 3, random influence results are shown in column 2, and fixed influence results are shown in column 1.

In addition, GF has a negative influence on GHG emissions. A 1% improvement in GF will decrease CO2 emissions by 1.89%. Our findings align with those of (Base & Srinivas, 2015), who asserted that GF had a negative influence on China's environmental pollution. Additionally, (Keen et al., 2019.) discovered comparable outcomes in Argentina. Table 5 shows that FD, FDI and PS has positive effect on GHGs across all models, which means that these are contributing in the GHGs emissions. our findings are consistent with the research conducted previously Salahuddin et al. (2018) and Dzankar Zoaka et al. (2022). International trade can also be important in promoting the sustainability of environments. As shows in Table 5.17 IT has negative effect on the GHGs emissions.

Table 5.17 Robustness Direct Influence

	(1)	(2)	(3)
VARIABLES	GHGs	GHGs	GHGs
GF	-0.016**	-0.017**	-0.0189***
	(0.00738)	(0.0076)	(0.00376)
FI	0.00538***	0.0348***	-0.0214***
	(0.0143)	(0.0149)	(0.0053)
FD	0.0792***	0.0823***	0.175***
	(0.0142)	(0.0145)	(0.0139)
IT	-0.0791***	-0.0615***	-0.043***
	(0.0176)	(0.0183)	(0.0109)
FDI	0.0326***	0.0341***	0.0306***
	(0.0050)	(0.00508)	(0.0026)
PS	0.0422***	0.0317**	0.0181**
	(0.0167)	(0.0172)	(0.0085)
Constant	9.24***	10.04***	
	(0.30)	(0.361)	
Hausman	58.41***		

Note ***, ** & * represents 1%, 5% & 10% significant level, (Standard errors).

5.4.1 Mediation influence of TI

Table 5.18 represents the mediating results of TI with representing model 2. Column (1)-(3) in Table 5.17 reflect independent variables (GF, FI, FD, IT, FDI & PS) have significant effect on GHGs emissions. Column (4) in table 5.18 represents that independent variable (GF, FI, FD, FDI, IT) have significant effect on the TI (mediator). Colum (3) reveals that both independent variables (GF, FI, FD, IT, FDI & PS) and mediator significantly affect the GHGs emissions.

Table 5.18 Robustness TI Mediation Results

	(1)	(2)	(3)	(4)
VARIABLES	GHGs	GHGs	GHGs	TI
GF	-0.016**	-0.017**	-0.0133***	0.042***
	(0.00735)	(0.0075)	(0.0049)	(0.010)
FI	0.0520***	0.0327**	-0.020***	-0.0508***
	(0.0143)	(0.0148)	(0.0051)	(0.0060)
FD	0.078***	0.081***	0.170***	-0.0517***
	(0.0141)	(0.0145)	(0.084)	(0.012)
IT	-0.0851***	-0.0675***	-0.0315***	-0.057***
	(0.0177)	(0.0183)	(0.0089)	(0.013)
FDI	0.0322***	0.034***	0.028***	-0.0438***
	(0.0049)	(0.00506)	(0.0019)	(0.0057)
PS	0.0465***	0.0361**	0.0099***	
	(0.0167)	(0.0172)	(0.011)	
TI	-0.03***	-0.0322***	-0.0030	
	(0.0097)	(0.0098)	(0.000)	
Constant	9.24***	10.05***		
	(0.30)	(0.36)		
Hausman	60.03***			

Note ***, ** & * represents 1%, 5% & 10% significant level, (Standard errors).

The results of column (4) reveal that GF and FD significantly promote TI that means 1 unit increase in the GF will increase TI by (0.03), while FI, FD, international trade and FDI have significant negative effect on TI. The results of column (3) reveal that the influence of TI as a mediator in the independent variables process has a major effect on GHGs emissions. The table

5.18 reveals that the combined influence of GF, TI, FI, FDI and IT will decrease the GHGs emissions which is eventually helpful in promoting environmental sustainability.

5.4.2 Mediation influence of NRR

Table 5.19 displays the findings of NRR as a mediator representing model 3. Table 5.17 columns (1)-(3) indicate that independent factors (GF, FI, FD, IT, FDI, and PS) have a significant effect on greenhouse gas emissions. In Table 5.19, column 4 indicates which independent variables (GF, FI, FD, FDI, and IT) have a substantial influence on the NRR (mediator). Colum (3) demonstrates that both independent factors (GF, FI, FD, IT, FDI & PS) and the mediator have a substantial effect on GHG emissions.

Table 5.19 Robustness NRR Mediation Results

VARIABLES	(1) GHGs	(2) GHGs	(3) GHGs	(4) NRR
GF	-.0153**	-0.017**	-0.0178***	-0.09***
	(0.0724)	(0.00753)	(0.0122)	(0.0149)
FI	0.028***	0.0326**	-0.0079**	0.134***
	(0.0140)	(0.0148)	(0.00323)	(0.0264)
FD	0.074***	0.078**	0.0743***	-0.90***
	(0.0139)	(0.014)	(0.0235)	(0.074)
IT	-0.09***	-0.0728***	-0.0430***	0.18***
	(0.0175)	(0.018)	(0.0088)	(0.025)
FDI	0.0318***	0.336***	0.0286***	0.38***
	(0.0049)	(0.0050)	(0.0020)	(0.0063)
PS	0.0324*	0.0293*	0.0429***	-0.46***
	(0.017)	(0.0173)	(0.0157)	(0.040)
TI	-0.023***	-0.280***	-0.0238***	
	(0.01)	(0.0099)	(0.00547)	
NRR	-0.065***	-0.040***	0.0132***	
	(0.0117)	(0.0125)	(0.00279)	
Constant	9.16***	9.89***		
	(0.30)	(0.36)		
Hausman	47.44***			

Note ***, ** & * represents 1%, 5% & 10% significant level, (Standard errors).

GF, FD, and public spending are negatively connected with NRR, but FI, international commerce, and FDI have a significant positive effect on NRR. The results of columns (3) indicate that the role of NRR as a mediator in the process of independent variables has a significant effect on GHG emissions. Table 5.19 demonstrates that the combined influence of GF, FI, NRR, and TI will reduce GHG emissions, which is beneficial for fostering environmental sustainability.

5.5 Robustness Check Model 2

This study uses three regression model D-GMM, Fixed Influence and Random influence model to check the robustness of the results as these were use before for the robustness check by the studies conducted by C. Liu et al. (2023) Osabuohien-Irabor & Drapkin, (2023). The purpose of conducting robustness checks is to verify the consistency and reliability of the results obtained from your primary analysis. The D-GMM method can help to alleviate endogeneity and cross-section dependence issues (Dou et al., 2021). Standard econometric techniques (RE and FE estimators for static panel data estimation and the D-GMM method for dynamic panel data estimation; outcomes provided in sections (1) through (4) of this article) are also used to guarantee the validity of the findings. D-GMM model results are shown in column 3, random influence results are shown in column 1, and fixed influence results are shown in column 2. The P value of the Sargan test in this article is 0.095 > 0.05, indicating that the null hypothesis "all the instrumental variables are exogenous" has been accepted, i.e., all the tools selected for this article are deemed valid. The autocorrelation test is then applied to the Difference GMM perturbation component. (AR test). For the AR (1) test, the P value is less than 0.05, while for the AR (2) test, it is greater than 0.05. We reject the null hypothesis of substantial correlations and accept the selected first-order delay interval because the approved model includes a random perturbation component. In conclusion, the paper's dynamic panel model is a reliable tool.

Table 5.20 Robustness Direct Influence

	(1)	(2)	(3)
VARIABLES	RNE	RNE	RNE
GF	0.053**	0.0560**	0.0297***
	(0.024)	(0.0232)	(0.00577)
FI	-0.3688***	-0.3482***	0.0779***
	(0.0449)	(0.0444)	(0.0071)
FD	-0.1213**	-0.1399***	-0.0736***
	(0.0461)	(0.0455)	(0.0183)
IT	-0.08566	-0.0574	-0.0540***
	(0.0563)	(0.0559)	(0.0155)
FDI	-0.088***	-0.091***	-0.050***
	(0.0158)	(0.0157)	(0.0056)
PS	0.092*	0.083	0.0998**
	(0.0531)	(0.0524)	(0.0345)
Constant	6.58***	4.83.***	
	(0.70)	(0.74)	
Hausman	0.4015		
Sargan			(0.095)
AR (1)			(0.000)
AR (2)			(0.262)

Note ***, ** & * represents 1%, 5% & 10% significant level.

The GF coefficient is positive, indicating a positive association between GF and renewable energy consumption RNE. Furthermore, it cleared the D-GMM test with a 1% significance level. For every 1% increase in GF, 2.97% more renewable energy will be consumed, showing that GF has a clear positive influence on renewable energy consumption RNE. This research's findings are similar to those of a previous study (D. Wu & Song, 2022) conducted in the European Union context, which found that FI has a positive influence on renewable energy consumption RNE. Second, in both random and fixed influence models, the FI coefficient produces contradictory findings. In D-GMM, the FI coefficient is positive, indicating that there is a positive association between FI and RNE. Furthermore, it cleared the D-GMM test with a 1% significance level. Renewable energy usage will rise by 1% for every 1% increase in FI. 7.79%, showing that improving FI will inflective promote renewable energy consumption, indicating that FI has a clear positive influence on renewable energy consumption RNE. This research's findings are similar to those of a previous study J. Li, Dong, et al. (2022) conducted in the Chinese context, which found that FI has a positive influence on renewable energy consumption. Third, as evidenced by their negative correlation coefficients, FD, international commerce, and FDI all have a negative correlation with RNE. Furthermore, it cleared the D-GMM test with a 1% significance level. Renewable energy consumption falls by 7.36%, 5%, and 5.4% for every 1% increase in FD, international trade, and FDI, respectively, showing that FD has a clear negative influence on renewable energy consumption. Previous study (S. Wang et al., 2020) suggests that higher-value exports consume more energy and emit more pollutants. Because traditional energy (coal) is more expensive than renewable energy, reducing exports of high-energy-intensive products promotes a rise in RNE. Fourth, the public spending coefficient is positive, suggesting a positive association between public spending and renewable energy consumption. Furthermore, it cleared the D-GMM test with a 1% significance level. For every one percent increase in government spending, 9.98% more renewable energy is consumed, showing that government spending has a clear positive effect on renewable energy consumption. Previous study by (Azhgaliyeva et al., 2023) conducted in 13 economies, reveals that public spending in R&D has positive effect on the renewable energy project, our study shows same results in 66 economies of the world.

5.5.1 Mediation Results

This paper uses the D-GMM methods for dynamic panel estimation as a standard regression technique to examine the effect of TI and NRR on the relationship between Green financial indicators and renewable energy consumption. In this study, we use STATA to compare our collected data to that of the chosen countries.

Table 5.21 Mediation of TI & NRR

VARIABLES	(1) RNE	(2) TI	(3) RNE	(4) NRR
GF	0.0109*	0.0559***	-0.0107**	-1.02***
	(0.0065)	(0.0062)	(0.0054)	(0.0204)
FI	0.0764***	-0.0545***	0.102***	0.563***
	(0.0142)	(0.0060)	(0.00996)	(0.0149)
FD	-0.510***	-0.050***	-0.0479***	-3.38***
	(0.0192)	(0.0076)	(0.0096)	(0.1199)
IT	-0.0334**	-0.0518***	-0.0293	2.88***
	(0.0158)	(0.0058)	(0.0181)	(0.160)
FDI	-0.0479***	-0.0526***	-0.0371***	-0.13***
	(0.0053)	(0.0045)	(0.00422)	(0.0268)
PS	0.00757**	0.027	-0.0246*	-4.99***
	(0.036)	(0.0175)	(0.0130)	(0.187)
TI	-0.0279**			
	(0.0130)			
NRR			-0.00506***	
			(0.00067)	

Note ***, ** & * represents 1%, 5% & 10% significant level.

The results are displayed in Table 5.21. The results are presented in columns (1) through (4). Column 1-2 represents the mediation mechanisms of TI while column 3-4 represents the mediation mechanisms of the NRR. To explore the mediating influence of TI and NRR, we follow the mechanism as it was followed by (M. Zhu et al., 2023). Table 5.21 displays the mediation results. Table 5.21 reveals a significant mediation of TI and NRR in the link among green financial indicators and RNE. GF has a positive coefficient, showing that there is a positive relationship among GF, TI, and renewable energy consumption RNE. It also passed the D-GMM test with a 1% relevance level. GF has a significant positive influence on the use of renewable energy. While NRR also mediates significantly, it reduces the influence of GF on renewable energy consumption, implying that NRR has a negative effect on the relationship among GF and renewable energy consumption RNE. The coefficient for FI is positive, showing a good relationship between FI, TI, and renewable energy consumption RNE. It also passed the D-GMM test with a 1% relevance level. FI has a clear favourable influence on the RNE. While NRR also mediates significantly, it increases the influence of FI on RNE when compared to the results in table 5.20, which are unmediated, implying that NRR positively mediates the correlation among FI and renewable RNE. The coefficient for FD, International Trade IT, and FDI is negative, showing that there is a negative link among FD, IT, and FDI, as well as TI and renewable energy consumption. It also passed the D-GMM test with a 1% relevance level. FD, IT, and FDI appear to have a negative influence on the RNE. While NRR and TI also play a role in mediating the relationship among FD, international trade, and FDI and renewable energy consumption, the results in table 4 show that NRR mediates the relationship among FD, IT and FDI and renewable energy consumption RNE, implying that NRR mediates the link between FD, international trade, and FDI and RNE. The coefficient for public spending is positive, showing that there is a favourable relationship between public spending, TI, and renewable energy consumption. It also passed the D-GMM test with a 1% relevance level. Public spending appears to have a noticeable positive influence on the use of renewable energy. While NRR mediates significantly, it reduces the influence of public spending on RNE, indicating that NRR negatively mediates the relationship between public spending and RNE.

5.6 Discussion

5.6.1 Detailed Discussion of Model 1

The objective of the study is to investigate the effect of the Green financial Indicator on the sustainable development having the mediation influence of TI in the 66 countries of the world by using the FMOLS and DOLS approaches to examine the long-term relationship. The findings of the study reveal that the different green financial indicators have different effect on the sustainable development The finding in the table 5.2 reveals that the GF has significant negative effect on the greenhouse gasses emissions, which is means GF is helpful in the reduction of the GHGs emissions that can promote the sustainable development. The result of our study is aligned with results of Dinh et al. (2022), Sadiq et al. (2022), Umar & Safi (2023). The study was conducted by Dinh et al. (2022) in the ASEAN countries with time period 2008-19 concludes that GF has negative effect on the GHGs emissions and helps to promote the sustainable development. A study conducted by the Sadiq et al. (2022) in the south Asia region with time period of 1995-2018 concludes that GF has negative effect on the greenhouse gas emissions. Another study conducted by Umar & Safi (2023) the in OECD countries context and found that GF is helpful in reducing the GHGs emission.

The finding of this study reveals that FI has positive effect on the greenhouse gas emissions which means that increase in the FI will decrease the environmental sustainability. This finding indicates that the population in the selected countries acquired a greater number of goods, such as motor vehicles, air conditioners, refrigerators, and television sets, because of increased access to finance. The widespread use of these products speeds up domestic fossil fuels energy use, which ultimately results in greater emissions of greenhouse gases in the selected countries. Additionally, it implies that the selected countries have allocated their financial resources to attain the objectives they have sought. The results of this study are aligned with results of the studies conducted by D. Liu et al. (2022), Tsimisaraka et al. (2023) and Zaidi et al. (2021). The study conducted by Tsimisaraka et al. (2023) for the top 10 OBOR countries with data for the period of 2004-19, found that the FI has significant positive effect on the GHGs emissions. Another study conducted by Zaidi et al. (2021) the 23 OECD countries with the data of 2004-17 period, found that FI causes the GHGs emissions. A study conducted by D. Liu et al. (2022) for the emerging Asian countries, found that there is the long-term positive effect of FI on the GHGs emissions.

The finding of this study reveals that FD has positive effect on the greenhouse gas emissions. These pieces of data suggest that the accessibility of financial loans from banking organizations and stock exchanges drives up investment and output levels, which in turn degrades the natural environment. The wealth influence, which may have resulted from a financial boom, may have enhanced consumer and company confidence, which would have resulted in an increase in energy consumption and GHGs emissions. This is another potential reason. The results of the study are aligned with the results of the studies conducted by Habiba et al. (2022), H. Khan et al. (2022) and Shahzadi et al. (2023). The study conducted by H. Khan et al. (2022) in the 180 countries with the time 2002-18, concludes that the FD has the positive effect the GHGs emissions.

A study conducted in Habiba et al. (2022) in OECD with the time of 1991- 2018 concluded that FD has the positive effect on the GHGs emissions. Another study conducted by Shahzadi et al. (2023) in the G-& countries context6 with time of 1997-2021, found that there is positive long run effect of FD on the GHGs emission.

The finding of this study reveals that international trade has positive effect on the greenhouse gas emissions which means international trade reduces the sustainability. The results of this study are aligned with the results of the studies conducted by Le et al. (2016) and S. Muhammad et al. (2020). A study conducted S. Muhammad et al. (2020) in the 65 BRI countries with data of the period pf 2000-16 concluded that the import increases the GHGs emissions in the lower income countries and export increase the GHGs emission in the middle- income countries. Another concluded by Le et al. (2016) that the international trade has positive effect on the GHGs emissions.

The finding in the table 5.2 reveals that the FDI has significant negative effect on the greenhouse gasses emissions, that's means FDI is helpful in the reduction of the GHGs emissions that can promote the sustainable development. The results of the study are aligned with the results of the studies conducted by Chien et al. (2023) and Kim & Seok (2023). The study conducted by Chien et al. (2023) for the G-7 nations, found that FD has negative effect on the GHGs emissions. Another study conducted by Kim & Seok (2023) in the south Korean context and taken the data 1971-2015, found that FDI has negative effect on the GHGs emission, which means it reduce GHGs emission and promote sustainable development.

The finding in the table 5.2 reveals that the public spending has negative effect on the greenhouse gasses emissions, which is means public spending is helpful in the reduction of the GHGs emissions that can promote the sustainable development, But the results are statistical insignificant that might be due to exceptionally low spending of the government. The results of the study are aligned with the results of the studies conducted by Halkos & Paizanos (2013) the for the 77 countries while considering the data of period 1980-2000, found that public spending has insignificant effect on the GHGs emissions.

5.6.2 Detailed Discussion of Model 2

The objective of the study is to investigate the effect of the Green financial Indicator on the renewable energy consumption having the mediation influence of TI in the 66 countries of the world by using the FMOLS and DOLS approaches to examine the long-term relationship. The findings of the study reveal that the different green financial indicators have different effects on the renewable energy consumption. The finding of the table 5.9 indicates that the GF has significant positive effect on the renewable energy consumption, which means that with the increase in the GF, renewable energy will also increase and eventually promote the sustainable development goals. The finding of this study is aligned with the results of the studies conducted by Alharbi et al. (2023), Lee et al. (2023) and Zheng et al. (2023). A study conducted by Alharbi et al. (2023), finds that the GF significantly fosters the renewable energy consumption of the selected 44 countries with the data of 2007-2020. Another study Lee et al. (2023) conducted in the Chinese context for the period pf 2001-19 found that the GF can effectively promote the renewable energy consumption. A study Zheng et al. (2023) conducted in the China for the time period of 2005-18, found the long-tern positive relationship between GF and renewable energy consumption.

The findings of the study indicate that the FI has negative effect on the Renewable energy consumptions, which means with the increase in the FI it will decrease the renewable energy consumption. This finding indicates that the population in the selected countries spendings on a greater number of goods, such as motor vehicles, air conditioners, refrigerators, and television sets, that can be invested in renewable energy system for their homes, because of increased access to finance. The widespread use of these products speeds up domestic fossil fuels energy use, which ultimately results in greater emissions of greenhouse gases in the selected countries. For FI to have an influence that is both good and significant on the utilization of renewable resources in certain economies, there is a requirement for suitable laws as well as policies to be implemented by the government. Tax exemptions, tax credits, and loans with low interest rates for projects linked to renewable energy can all be considered as potential incentive programs that can be used to encourage both individuals and businesses to use renewable energy sources. In addition, subsidies for the use of renewable energy sources could be made available. Therefore, governments should construct a financial structure that is compatible with a context that can encourage the use of renewable sources of energy. The results of the study are aligned with the results of the study Talan et al. (2023) that was conducted in G-7 countries and found that there is significant negative relationship between the FI and Renewable energy Consumption.

The findings of the study indicate that the FD has positive effect on the Renewable energy consumptions, which means with the increase in the FD it will increase the renewable energy consumption. The findings of the study are aligned with the studies conducted by Mukhtarov et al. (2022), Prempeh (2023) and Sun et al. (2023). A study conducted by the Mukhtarov et al. (2022) in the Turkish context for the period of 1980-2019 found the positive correlation between the FD and the renewable energy consumption. Another study Sun et al. (2023) gives the global perspective by taking=g the data of 103 countries and also find that there is positive relationship between the FD and Renewable energy consumption. A study Talan et al. (2023) conducted in

Ghana also found that there is positive relation between FD and renewable energy consumption. The finding shows that the FD significantly promotes the renewable energy.

The findings of the study indicate that the international trade has positive effect on the Renewable energy consumptions, which means with the increase in the international trade it will increase the renewable energy consumption. The findings of the study are aligned with the studies conducted by Chen et al. (2023) and I. Muhammad et al. (2022). A study I. Muhammad et al. (2022) conducted in the 23 OECD countries found that the international trade can foster the renewable energy. Another study Chen et al. (2023) conducted in the China with the data taken from the 2000-2019 found that the international trade has the significant positive effect on the renewable energy consumption.

The findings of the study indicate that the FDI has negative effect on the Renewable energy consumptions, which means with the increase in the FDI it will decrease the renewable energy consumption. The findings indicate that the FDI is detrimental to the renewable energy consumption. The findings of the study are aligned with the results of the study A. Khan et al. (2021) that was conducted in the 69 BRI countries with data for the period of 2000-2014 and found that FDI have the negative effect on the renewable energy consumption.

The finding in the table 5.9 reveals that the public spending has positive effect on the Renewable energy consumption, which is means public spending is helpful in the promotion of the Renewable energy Consumption that can promote the sustainable development, But the results are statistical insignificant that might be due to exceptionally low spending of the government. The results of the study are aligned with the results of the studies conducted Caglar & Yavuz (2023) for the European Union’s context and found that the government expenditure (public spending) has insignificant effect on the renewable energy consumption.

In this study, we set out to test a series of hypotheses aimed at understanding the relationships between green financial indicators, renewable energy consumption and sustainable development. The table provided below presents a concise summary of the hypotheses and the corresponding results, indicating whether each hypothesis was accepted or rejected based on the statistical analyses performed.

Table 5.22 Summary of Results

	Summary of Results	
	Research Hypothesis	**Results**
1	There is a correlation between the green financial indicators and Sustainable development.	Accepted
2	Technological Innovation mediates the relationship between Green Financial Indicators and Sustainable Development.	Accepted
3	Natural Resource Rent mediates the relationship between Green Financial Indicators and Sustainable Development.	Accepted
4	There is a correlation between the green financial indicators and Renewable Energy Consumption.	Accepted
5	Technological Innovation mediates the relationship between Green Financial Indicators and Renewable Energy Consumption.	Accepted
6	Natural Resource Rent mediates the relationship between Green Financial Indicators and Renewable Energy Consumption.	Accepted
	Sub Hypothesis	
	Public spending and sustainable development are correlated	Rejected
	Technological Innovation mediates between the relationship between public spending and Sustainable development.	Rejected
	Natural Resource Rent mediates the relationship between public spending and Sustainable Development.	Rejected
	Public spending and Renewable energy are correlated	Rejected
	Technological Innovation mediates between the relationship between public spending and Renewable Energy	Rejected
	Natural Resource Rent mediates the relationship between public spending and Renewable Energy	Rejected

CHAPTER SIX

CONCLUSION & RECOMMENDATION

This chapter concludes the research findings, highlighting the significant role of GF in promoting sustainable development and achieving carbon-neutrality targets. Recommendations include expanding green financing mechanisms and implementing carbon pricing mechanisms. Limitations include the focus on specific countries and the reliance on quantitative data. Further research is encouraged to address these limitations and deepen the understanding of GF's effect on sustainability.

6.1 Conclusion

In the past three decades, the issue of sustainability has become the focal point of all international forums, assuming a position of utmost importance. Designing a generic societal and economic paradigm that can articulate economic viability, social inclusion, and environmental sustainability is one of the greatest challenges of the twenty-first century. The most efficient method for addressing the environmental challenges faced by countries is to place an emphasis on sustainable development. To address the substantial problems that have arisen as a consequence of environmental deterioration and global warming caused by human activity, it is necessary to adopt financial processes that are socially and ecologically responsible. One such process is green finance. It is of the utmost importance to disentangle economic growth and development from the process of damaging environmental systems by implementing modifications to fundamental business practices. Because of the growing number of risks to the natural world, environmentally responsible investment is now absolutely necessary in the modern period to accomplish the goal of sustainable development. The idea of funding projects with green bonds came to widespread attention in 2008 and has seen consistent expansion since then.

For public authorities, who are crucial in terms of collective regulation for sustainable and shared prosperity, green finance represents a new paradigm. The pursuit of green development is the ultimate solution for battling climate change, and most governments have been transitioning during the past 20 years to establish a wide range of environmental and employment legislation to increase environmental quality, social welfare, and productivity. Despite the fact that previous studies have focused on the determinants of environmental quality, very few have examined the aspects of sustainable development. This study examines Influences of green financial indicators on the Sustainable development and Renewable energy Consumption with the mediating Influence of TI and NRR that can improve the sustainability in the selected 66 countries and the data were obtained of the time period 2004-2019 in order to cover this void in the literature. The initial data diagnostic test verified the variables' cross-sectional dependencies. Second generation Unit root tests were run to address the cross-sectional dependency between the variables. Most variables are stationary at first difference, according to the results of the second-generation unit root test (CIPS & CADF) and cointegration test including Westerlund, Pedroni & Kao, and there was co-integration in the data, which supports a long-term relationship between the variables. As a result, the study used the FMOLS and DOLS models to address the serial correlation and heterogeneity problems and explore the long-term interactions between the Green Financial Indicators, RNE Consumption, and Sustainable Development.

The findings of the study shows that the green financial indicators can play a crucial role in promoting sustainable development and achieving sustainable development goals and carbon-neutrality targets set by the United Nation. The findings of the study show that GF effectively reduces the GHGs emissions and promotes the RNE consumption that will eventually be helpful in the achievement of carbon neutrality targets and the sustainable development goals (SDGs). The study shows that the FI has significant negative effect on RNE consumption and positive effect on the GHGs emission that indicates that the FI has detrimental Influence on sustainable development. On the other hand, FD has a negative effect on sustainable development, but FD plays a crucial role in promoting the RNE consumption. The effect of FD on the GHGs is a little with coefficient of (0.02) and has positive effect on the RNE consumption with the coefficient (0.38). Overall, findings show FD is helpful in promoting RNE consumption. Similarly, International trade has a positive effect on the GHGs and the RNE consumption. The effect of international trade on the GHGs is a little with coefficient of (0.07) and has positive effect on the RNE consumption with the coefficient (0.39). Overall, findings show international trade is helpful in promoting RNE consumption. FDI has significant negative effect on GHGs emissions and RNE consumptions, which indicates that FDI can play vital role in reducing the GHGs emissions. Public spending has the negative effect on the GHGs emissions and has positive effect on the RNE consumptions that indicates public spending can be crucial in achieving the sustainable development goals but the finding for the public spendings is statistically insignificant.

Lastly, this is the first study that investigate the mediation effect of the TI and natural resources rent in the nexus between the GF and sustainable development. The findings of the mediation Influence reveal that the TI and NRR significantly mediate between the relation among the green financial indicator’s RNE consumption and sustainable development. TI and NRR positively mediate between the green financial indicators, RNE consumption and Sustainable developments. While TI and NRR negatively mediate between the green financial indicators, RNE consumption and Sustainable developments.

In conclusion, this study examined the impact of green financial indicators on sustainable development and RNE consumption in 66 selected countries. The findings highlight the crucial role of GF in promoting sustainable development and achieving carbon-neutrality targets and sustainable development goals. FI was found to have a detrimental Influence on sustainable development, while FD played a crucial role in promoting RNE consumption. International trade and foreign direct investment had positive effects on RNE consumption, with foreign direct investment also reducing greenhouse gas emissions. Additionally, the study revealed that TI and NRR played significant mediating roles in the relationship between GF, RNE consumption, and sustainable development. These findings provide valuable insights for policymakers and emphasize the importance of integrating green financial indicators and promoting RNE to achieve sustainable development goals.

6.2 Recommendations

6.2.1 Recommendations for Policy makers

The findings of this study hold important recommendations for policy development and implementation. The identified forms of environmental deterioration and their associated effects are likely to be prevalent across these countries, highlighting the need for urgent action. Policymakers in these nations can utilize the study's findings to establish effective policies that address their specific environmental challenges. One key recommendation is to prioritize the implementation of green financing mechanisms in these countries. By promoting and facilitating investments in RNE and environmentally sustainable projects, governments can drive economic growth while simultaneously addressing environmental concerns. This includes developing policies that encourage financial institutions to support and fund green initiatives, as well as providing incentives and subsidies to attract private investments in RNE.

Additionally, these selected 66 countries should consider adopting policies aimed at reducing their carbon emissions. The study suggests that implementing CO_2 taxation policies can be an Influence strategy to incentivize businesses and individuals to reduce their carbon footprint. This can be coupled with the allocation of tax revenues towards green technologies and businesses, further promoting sustainable development and mitigating the negative effect of the tax on the economy.

Furthermore, it is crucial for these countries to prioritize environmental quality. Strengthening governance frameworks, ensuring regulatory compliance, and enhancing environmental monitoring and enforcement can contribute to the overall effectiveness of environmental policies. This includes establishing mechanisms to monitor and measure environmental performance, as well as fostering collaborations between public and private entities to drive innovation and sustainable practices. Given the diverse economic, social, and environmental contexts of the 66 countries, it is essential to tailor policies to their specific needs and capacities. Policymakers should conduct thorough assessments of their country's environmental challenges and engage in evidence-based decision-making processes. International collaboration and knowledge-sharing among these countries can also play a vital role in identifying best practices and fostering collective action towards sustainable development.

Overall, the findings of this study provide valuable insights and recommendations for policymakers in the 66 countries, highlighting the importance of green financing, carbon reduction measures, and institutional and environmental quality. By implementing these policies effectively, these countries can make significant strides towards sustainable development, mitigating environmental degradation, and securing a more resilient future for their citizens.

6.2.2 Recommendations for Researchers

In the context of GF and Sustainable development, the present analysis is the first step toward a deeper understanding of how collectively green financial indicators play crucial role in promoting the sustainable development. To the best of our knowledge, this study is the first that investigates the mediation Influence of TIs and natural resources rent between the green financial indicators, RNE consumption in the context of Sustainable Development. However, this study provides recommendations that can be addressed by future researchers. First, despite the fact that this study provides vital insights within the selected countries, it is essential to recognize that the effect of green financial indicators varies considerably across the nations. In addition, future researchers should replicate this study using a diverse group of countries in order to obtain more accurate and exhaustive results. In additions future studies can conduct comparative analysis among the different regions and the group of countries like developing and non-developing countries. Furthermore, undertaking cross-national comparisons, particularly within India, Canada, the United States, China, and other major CO_2 emitters, would provide additional insight into the nuances and differences in green economic growth patterns. Future researchers can also investigate the mediation of governance and financial risk in the context of GF and sustainable development. Future studies can also look after the Influence of the tax policies on the green financing projects.

6.2.3 Policy Recommendation for institution

In order to oversee the problems caused by increasing temperatures and more intense weather events, nations will need to devote a portion of their budgets to the improvement of the environment. This will encourage the development of environmentally friendly assets on the market and ensure the future well-being of their inhabitants. In order to encourage firms to move toward a green economy, policymakers need to provide new options for both fiscal and monetary incentives. We are able to cut down on environmental pollution and the emission of gases that contribute to pollution if we provide economic incentives to stimulate the economy, promote environmentally friendly industries, and build production facilities that are sustainable. Both public cash and government subsidies are viable options for aiding public-private partnerships working in the sector of RNE.

In addition, governmental organizations and authorities ought to be actively supporting the development of the circular economy as well as greener energy products. The shift toward the use of renewable sources of energy is being pushed forward not only by environmental concerns but also by geopolitical tensions and the requirement for increased energy security. Green bonds, climate change projects, and clean energy assets can all be included in an investor or fund manager's portfolio if they make the adjustment to include these types of investments. These investments can be thought of as environmentally beneficial assets, and they offer the possibility of hedging against a variety of risks, including geopolitical dangers.

The government ought to encourage the use of offshore wind power to participate in the national carbon emission trading market. The funding of offshore wind power projects can be made easier if the usage of green credits is increased to a greater extent. Even though offshore wind generating firms may see a decrease in their profitability in the short term, particularly as a result of the COVID-19 epidemic, the inclusion of these enterprises in the national carbon market may help offset some of the costs that are connected with their operations. The availability of GF makes it possible for investors in offshore wind generating projects to take advantage of financing options that are more affordably priced.

Lastly, institutions should prioritize allocating budgets towards environmental improvement and promoting green assets to ensure a sustainable future. Policymakers must provide fiscal and monetary incentives to encourage businesses to transition to a green economy and invest in RNE. Additionally, supporting the participation of offshore wind power in the national carbon market and expanding the use of green credits will facilitate financing and promote the growth of this sector. These recommendations will help institutions drive sustainable development and combat environmental challenges effectively.

6.3 Limitations

While this study provides valuable insights into the relationship between GF, sustainable development, and RNE consumption, it is essential to acknowledge certain limitations. First, the study focused on a specific set of 66 countries, and the findings may not be representative of the global context. Therefore, caution should be exercised when generalizing the results to other countries or regions. Secondly, the data used in this study covers the time period from 2004 to 2019, and more recent developments or policy changes might not have been fully captured. Future research should consider incorporating more up-to-date data to provide a comprehensive analysis. Lastly, future research should look after the alternate analysis for the same Panel data. Despite these limitations, this thesis serves as a valuable contribution to the existing literature and provides a foundation for further research in this field.

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Annexure

Annexure A

List of Countries

Sr No.	Country	Sr No	Country	Sr No	Country
1	Armenia	23	India	45	Portugal
2	Azerbaijan	24	Indonesia	46	Philippines
3	Albania	25	Iran	47	Qatar
4	Austria	26	Iraq	48	Romania
5	Bangladesh	27	Ireland	49	Russia
6	Belarus	28	Israel	50	Saudi Arabia
7	Belgium	29	Italy	51	Serbia
8	Bosnia	30	Japan	52	Singapore
9	Bulgaria	31	Jordan	53	Slovak Republic
10	China	32	Kazakhstan	54	Slovenia
11	Cyprus	33	Kuwait	55	Spain
12	Croatia	34	Malaysia	56	Sweden
13	Czech	35	Malta	57	Switzerland
14	Denmark	36	Mongolia	58	Sri Lanka
15	Estonia	37	Moldova	59	Tajikistan
16	Finland	38	Montenegro	60	Thailand
17	France	39	Myanmar	61	Turkey
18	Georgia	40	Nepal	62	Ukraine
19	Germany	41	Netherland	63	UK
20	Greece	42	Norway	64	Uzbekistan
21	Hungary	43	Pakistan	65	Vietnam
22	Iceland	44	Poland	66	Yemen

Annexure B

List of Variables

Dependent Variables	**Notation**	**Indicator**	**Database**
Renewable Energy Consumption	RNE	Renewable energy consumption % total energy	WDI
Sustainable Development	GHGs	Greenhouse gas emissions	WDI
Independent Variables			
Green Finance	GF	Environmental Protection Product by Resident	OECD
Financial Inclusion	FI	Atm per lac, Branches per Thousand, bank borrower per lac	WDI
Financial Development	FD	Domestic & foreign loan to private sector	WDI
Public Spending	PS	Education, R&D	WDI
International Trade	IT	Exports, Imports	WDI
Foreign Direct Investment	FDI	FDI net flow	WDI
Control variables			
Population Growth	PG	% Annual Growth of Population	WDI
Urbanization	URB	Urban population % of total	WDI
Industrialization	IND		WDI
Economic Growth	EG	% Annual Growth of GDP	WDI

Trade Openness	TO	% Merchandise Export	WDI
Literacy Level	LL	Enroll Student over 15 years	WDI
Other Variables			
Natural Resource	NR	Natural resource Rent	WDI
Technological Innovation	TI	Medium-High Tech export	WDI

Annexure C

Data Used in the Study

Country	ID	year	GHGs	RNE	GF	FI	FD	IT	FDI	PS	PG	URB	TO	EG	IND	LL	NRR	TI
Armenia	1	2004	11.29203	4.387884	2.926466	2.300981	1.634061	3.323262	0.811262	0.887389	0.151504	3.323596	3.875935	2.617052	2.734225	3.691781	2.26858	0.63427
Armenia	1	2005	8.954157	2.285439	0.174353	0.863887	5.54248	0.687489	4.688055	0.282136	0.256109	4.206735	3.551479	1.261039	2.37586	4.557028	3.173612	3.930291
Armenia	1	2006	9.770527	3.112626	2.312535	0.728354	4.179698	0.985318	1.537799	1.153052	1.997115	3.976537	4.935873	1.261039	3.313784	4.588639	1.566195	4.12433
Armenia	1	2007	10.90504	2.895912	1.663926	1.253282	4.956773	0.032732	0.56039	1.164049	0.374801	4.296632	4.074941	1.037279	3.245283	4.54097	4.289682	4.217398
Armenia	1	2008	8.793309	2.164472	2.992728	0.460184	3.261516	0.122916	1.932956	0.628714	0.228574	4.159477	4.060232	2.351375	3.287687	4.534665	3.829388	2.840864
Armenia	1	2009	10.90999	3.023347	2.322388	1.147831	5.028922	0.468362	1.074443	0.219382	0.040718	4.29874	4.121131	1.184209	3.215746	4.560187	4.203353	4.239105
Armenia	1	2010	10.85727	3.085573	2.242835	1.088756	5.080762	0.582061	1.752892	1.24429	0.059984	4.299365	4.476299	0.196548	3.213853	4.568703	4.500912	4.254868
Armenia	1	2011	11.05073	3.01896	3.044046	0.913965	3.854114	0.105093	1.398458	0.035375	0.228574	4.007206	4.150084	0.313281	3.230285	4.516169	0.972683	3.507573
Armenia	1	2012	12.38652	3.610107	1.272566	1.689564	4.637854	0.131542	1.969741	1.006675	0.020806	3.393232	4.786134	1.68601	3.716634	4.1103	2.022401	3.251792
Armenia	1	2013	11.92252	1.021651	2.36742	4.733501	0.236594	0.820691	0.199613	2.41457	0.94646	4.229924	4.670789	3.97747	4.124471	3.747188	4.188043	3.500027
Armenia	1	2014	11.3314	4.379774	2.90673	2.353433	1.678268	3.327806	0.796831	0.886637	0.235042	3.330274	3.983063	2.607636	2.834701	3.76734	2.485254	0.63427
Armenia	1	2015	11.36848	4.400112	2.94582	2.550549	1.500664	3.318729	0.843711	0.964937	0.335837	3.336908	4.088595	2.58828	2.918306	3.791827	2.531003	0.63427
Armenia	1	2016	11.39729	4.390739	2.866051	2.536165	1.380292	3.336925	1.515865	1.126096	0.434108	3.343533	4.109757	2.525768	2.99161	3.835384	2.684656	0.63427
Armenia	1	2017	11.37848	4.45097	3.019693	2.51496	1.244508	3.3007	1.322789	1.08863	0.479477	3.35015	3.879473	2.404624	3.075654	3.83382	2.70326	0.63427
Armenia	1	2018	11.39042	4.448282	2.68444	2.501062	1.316014	3.373829	1.29831	1.039138	0.445822	3.356723	3.621105	2.342752	3.164116	3.882565	3.017211	0.63427
Armenia	1	2019	11.41388	4.441827	3.270329	2.473817	1.638531	3.230189	0.868864	1.059946	0.363831	3.363322	3.569786	2.30949	3.241707	3.869799	3.117243	0.63427
Azarbaijar	2	2004	11.40378	4.431769	1.091923	2.377632	1.982191	3.528777	1.538177	0.966797	0.264797	3.369879	3.518541	2.017574	3.36946	3.874061	2.96559	0.63427
Azarbaijar	2	2005	10.07996	1.280934	4.60517	2.400849	1.666943	0.049924	1.161041	0.858702	0.857408	3.601195	3.792391	0.284424	3.572646	3.885199	2.39317	0.574578
Azarbaijar	2	2006	11.57862	2.995732	3.608212	0.485151	4.260459	0.276238	0.41234	0.21619	1.444506	4.594564	4.224929	1.558849	4.050755	4.563609	2.923384	0.0881
Azarbaijar	2	2007	12.5866	0.562119	2.48948	1.493214	2.256524	0.962407	1.161041	2.317238	0.932517	4.252459	4.092379	1.261039	3.938269	4.047216	3.637482	3.283799
Azarbaijar	2	2008	12.62324	0.71335	2.066863	1.392138	2.149436	1.02945	1.161041	2.378903	0.8409	4.25523	4.187283	0.968447	3.992126	4.053642	3.796469	3.283799
Azarbaijar	2	2009	12.67864	0.84397	2.785628	1.501015	2.175769	0.60969	1.161041	2.617305	0.812768	4.258134	4.007887	1.707252	3.972354	4.040191	3.675743	3.283799
Azarbaijar	2	2010	12.05925	0.19062	2.367943	1.293691	1.329388	0.139185	0.358674	2.323645	0.717006	4.233817	4.276325	1.217668	3.951047	4.167192	3.649956	2.745917
Azarbaijar	2	2011	10.13698	1.134623	4.60517	2.403199	1.669864	0.251449	1.161041	0.883662	0.833167	3.618269	3.994526	0.336472	3.572646	3.88211	2.388269	0.574578
Azarbaijar	2	2012	10.77604	1.22083	1.965713	1.455591	4.042054	0.342868	1.161041	1.122906	0.648892	4.223866	4.304041	0.398631	3.501889	4.530371	2.312524	1.179317
Azarbaijar	2	2013	11.72675	2.080691	2.727199	0.750808	4.27674	0.697518	1.281019	0.13124	1.226733	4.310155	3.425146	0.512257	2.879451	4.562953	2.016569	3.596816
Azarbaijar	2	2014	9.149528	2.576422	2.224624	0.318358	3.889279	0.007892	1.151998	0.507852	1.018156	4.144436	3.871765	1.609438	3.241699	4.454416	1.505899	2.370887
Azarbaijar	2	2015	12.96634	2.580217	2.605648	0.831439	4.544244	0.617724	1.593296	1.049921	0.747166	4.374423	3.785292	0.044806	2.876157	4.648006	3.068795	4.178223
Azarbaijar	2	2016	11.27556	3.543565	2.490723	0.089771	4.527833	0.360141	2.255108	1.2752	0.528672	4.048929	4.422683	3.668892	3.239656	4.583368	1.495382	4.111829
Azarbaijar	2	2017	11.22724	3.57431	2.549445	0.137865	4.472274	0.340273	0.949697	1.312173	0.246487	4.052237	4.399472	0.413589	3.233356	4.597112	1.668138	4.127899
Azarbaijar	2	2018	11.16124	3.544143	2.525729	0.058485	4.383281	0.041539	1.915787	1.430339	0.764537	4.422437	4.187867	0.243353	3.386531	4.701516	0.94628	4.015052
Azarbaijar	2	2019	10.9032	3.766535	2.616666	0.711484	4.548055	0.312606	2.008919	1.250629	1.110531	4.445295	3.937116	0.609433	3.148703	4.986531	0.880305	3.836244
Albania	3	2004	13.09491	2.360854	2.415914	0.994055	4.52748	0.718322	0.841779	0.964403	0.581886	4.355015	3.817522	1.366704	2.934592	4.669961	2.928926	4.172919
Albania	3	2005	13.03963	2.512846	2.70069	0.85653	4.570109	0.637837	0.205058	1.031199	0.725673	4.367902	3.835611	1.161122	2.883042	4.669183	3.005387	4.16586
Albania	3	2006	13.04174	2.596746	2.652538	0.846727	4.564559	0.644286	0.116381	1.035049	0.664028	4.371155	3.804356	0.551081	2.888804	4.661679	3.019468	4.175285
Albania	3	2007	13.66896	2.613007	2.727853	0.183234	4.428517	0.093616	0.618108	1.253538	1.672762	4.346011	4.283112	0.871084	3.3063	4.642104	1.803154	4.275919
Albania	3	2008	13.68773	2.612273	2.660959	0.132332	4.407918	0.120579	0.587656	1.239753	1.298649	4.34614	4.253319	0.82647	3.287753	4.626615	2.098017	4.282755
Albania	3	2009	13.23073	1.902108	1.951608	1.242649	4.260574	1.053165	0.682264	0.37777	0.710519	4.215647	3.708382	0.201078	3.147233	4.595301	2.347877	3.992134
Albania	3	2010	13.06573	2.476538	2.430978	1.264871	4.543936	0.787086	0.406643	0.498756	1.760387	4.226016	3.853293	0.346253	3.0796	4.633795	2.969004	3.98774
Albania	3	2011	11.32744	2.894253	2.522524	1.430546	4.826496	0.318925	0.534979	0.100743	1.684527	4.052168	3.952091	0.246095	3.062611	4.554577	1.804871	3.784172
Albania	3	2012	11.2156	3.143721	2.774462	1.369301	5.020461	0.064072	1.088001	0.656964	1.936615	4.083604	4.05237	1.141787	3.014862	4.624609	1.552251	3.759874