Assessing the relationship between Greenhouse Gases Emissions and Financial Risk: The role of Green Growth, Technological Innovation, Financial Inclusion, Renewable Energy, and Soft Infrastructure

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Certificate

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DEDICATION

Every challenging work needs self-effort as well as guidance of those who are very close to our heart.

My humble efforts are dedicated to my sweet and loving.

Parents & Wife,

Their affection, love, encouragement and prayers of days and nights made me able to get such success and honor,

Along with all hard working and respected

Teachers

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List of Abbreviations

GHG	Green House gases
FR	Financial Risk
GG	Green Growth
FS	Financial Stability
RE	Renewable Energy
TI	Technological innovation
FI	Financial Inclusion
SI	Soft infrastructure
SU	Sustainable Development
ED	Environmental degradation
MDG	Millennium Development Goals
TFEE	Total-factor energy efficiency
IPCC	Intergovernmental Penal on Climate Change
COP	Conference of the Parties
OECD	The organization for Economic Cooperation and Development
GDP	Gross Domestic Product
R&D	Research and Development
EWM	Entropy Weighted Method
CCP	Climate Change Potential
ICT	Information and Communication Technology
CADF	Cross Sectional Augmented Dickey Fuller
CIPS	Cross Sectionally Augmented Panel

Title

Assessing the relationship between Greenhouse Gases Emissions and Financial Risk: The role of Green Growth, Technological Innovation, Financial Inclusion, Renewable Energy, and Soft Infrastructure

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Abstract

The concept of sustainable development has gained significant attention in recent years as societies face mounting environmental, social, and economic challenges. This thesis undertakes a comprehensive examination of sustainable development, aiming to understand its multifaceted dimensions and propose a roadmap for its achievement. The study begins by providing a theoretical foundation for sustainable development, exploring its origins, principles, and frameworks. It investigates the interconnectedness of environmental conservation, social equity, and economic prosperity, emphasizing the need for an integrated approach to address the complex issues at hand. The study basically follows two research models, dependent variable (greenhouse gas emissions) for model-1 and financial risk for the 2^{nd} model. However, the independent variables which includes green growth, technology innovation, renewable energy, financial inclusion, and soft infrastructure. The methodology followed for this study is quantitative approach with secondary data ranges from 2004 to 2019. The data is collected from the World Development Indicators and the organization for Economic Cooperation and Development database. For the green growth the index is made with entropy weighted method to better represent the variable indicators. The diagnostic tests were used to solve the issue of panel data set which includes, correlation, VIF, cross sectional dependency, fixed random & Hausman, stationarity tests and cointegration. The diagnostic tests results suggested that appropriate method to follow for this panel is Fully Modified ordinary least square and Penal Dynamic ordinary least square. The findings Financial risk, financial inclusion and soft infrastructure are statistically significant and positive relationships with Green gases emission renewable energy technology innovation green growth significant negative relationship with greenhouse gases the long run variance is 66% and model greenhouse gases financial inclusion and soft infrastructure significant positive and green growth renewable energy and technology innovation significant negative relationship with financial risk long run variance is 55%. The results suggest that the government to give incentives to the institutions in the field of alternative energy to institutions should shift toward renewable energy and contribute to improving environmental quality. Government can develop policies and regulate the fund toward sustainable development, which can be helpful in environmental sustainability.

Key Words: *Renewable Energy, Financial Risk, Climate change, Sustainable development goal, Green growth, Environmental degradation,*

CHAPTER 1

INTRODUCTION

1.1 Introduction

In this chapter, we provide a brief discussion of the background of the study, highlighting its relevance and connection to existing research. We also present the problem statement, identifying the specific issue we aim to address and the research gap in the field. Furthermore, we outline the study's objectives, explain what to achieve, and emphasize the significance of the research. Finally, we discuss the practical implications of the study, highlighting how the findings can be applied in real-world scenarios. This chapter sets the foundation for the rest of the thesis, establishing the importance and context of the research.

1.2 Background of the Study

Global climate change is human beings' most significant problem in the twentieth century. United Nation framework on ED, describes the "climate system" as "the entirety of the atmosphere, hydrosphere, biosphere, and geosphere and their interactions." Numerous studies identified the effect of ED are an increase in the sea level, the rise of 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).

Our society frequently experiences abrupt, unanticipated shifts over which humans have little influence. Innovation is essential for worldwide growth and development, as well as for the survival of businesses. However, technology and innovation frequently rely on substantial use of fossil fuels, preceding to increased atmospheric CO_2 and other environmental pollution (Kylliäinen, 2019).

Since the economic revolution, the use of fossil fuels has risen dramatically, resulting in increased CO_2 emissions and other greenhouse gases (GHGs) that pose a grave environmental threat. In the last several decades, global CO_2 emissions have consistently risen. Global CO_2 From 2003 to 2018, emissions rose from 25,715.7 Mt of CO_2 to 33,890.8 Mt, a 31.79 percent increase. From 2003 to 2018, emissions rose from 25,715.7 Mt of CO_2 to 33,890.8 Mt, a 31.79 percent increase. As the primary factor in global warming (GHGs), CO_2 emissions significantly impact global warming. Various problems with the environment and society, such as rising sea levels, desertification, and glacier melting, have been precipitated by the escalation of the greenhouse effect, all of which have the potential to have catastrophic effects about the history of organized society (Ahmad et al., 2018).

These Greenhouse Gases (GHGs) are responsible because of climate change and environmental deterioration. Industrialization has led to numerous social and climate change and other environmental concerns, to boost economic growth. Climate change's consequences on the environment and the survival of living species are adverse. Recent research indicates that an increase of 1.09°C occurred at the earth's surface between 2011 and 2020 than between 1850 and 1900. Global warming will result in a 1.50°C average temperature increases over the next two decades. These adverse climate change effects have the same global reach (Irfan et al., 2022).

Quantifying emissions by source type for the second-largest contributor to climate change, the greenhouse gas methane, sources, and sinks coincide, is challenging. Since 2007, the global concentration of mine that an increase of 1.09°C occurred at the earth's surface than in the atmosphere has increased at an accelerated rate. The yearly growths for 2020 and 2021 were 15 and 18 ppb, respectively. It will be the highest since systematic recordings began in 1983. It is not yet possible to determine whether the significant climate feedback is the reason for the predicted rises in 2020 and 2021. If the temperature rises, organic matter decomposes faster. Methane emissions result from decomposition in water (without oxygen). If tropical wetland conditions become moist and warmer, then an increase in emissions is possible. The extraordinary increase may also be due to natural interannual variation. La Nia events, associated with increased tropical precipitation, occurred in 2020 and 2021 (Greenhouse et al. | World Meteorological Organization, 2023).

A global census is undertaken every five years to calculate the necessary emission reductions. This would demand substantial, long-term reductions in carbon dioxide emissions throughout the twenty-first century. The United Nations Environment Program reliable progress means satisfying current necessities while preserving. It is important to ensure that future generations have the means to fulfill their own requirements. Energy sustainability evaluations consider the role of energy's negative externalities and emerging severe ecological issues and energy crises threaten society's ability to evolve sustainably. However, these objectives are accomplished at a different rate. Rising global temperatures have 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 2.3%, or 2.3 billion individuals, of the global population were hungry last year (Provisional State of the Global Climate 2022).

Supporting highly reliant communities and ecosystems modify to fit the new climate is an urgent worldwide issue now. These "soft" constraints might include a lack of technical support or financing that is not distributed to areas where it is needed, or a lack of political stability will to address the issue and however, in other areas, people and ecosystems have reached or are quickly approaching "hard" adaptation limits, meaning that climate impacts from global warming of 1.1 degrees Celsius occur with such regularity and intensity that they current adaptation strategies can entirely prevent losses and damages. For instance, tropical coastal communities have seen the destruction of whole coral reef systems that provided them with a means of subsistence and protection from hunger. Meanwhile, other low-lying populations have been forced to move to higher land and abandon cultural monuments due to increasing sea levels. These costs will rise as the planet heats. If global temperatures rise by more than 1.5 degrees Celsius, areas that rely on glacial and snowmelt runoff would face severe droughts. The likelihood of simultaneous failures in maize output in key growing regions increases considerably around 2ºC. Perilously high summer temperatures exceeding 3 degrees Celsius will also threaten the health of people in southern Europe (Schumer & Arogyaswamy, 2023).

The World Commission on Development and the Environment's Report, produced after 900 days of discussion by an international group of legislators, civil servants, and experts on development and the environment, is the most critical statement regarding sustainable development. Since the publication of limitations to growth and Conference of the United Nations (UN) on the sociocultural context, numerous individuals have become convinced that the planet's environment is swiftly degrading. Thus, as the human population increases by 100 million annually, the earth’s ability to support humanity decreases. Brundtland's 2021 analysis of the current state of the world begins with identifying a disparity between the capabilities of the earth's natural systems and the capacity of human activities to fit within this framework. Approximately 30,000 individuals attended the most prominent environmental conference ever held in Rio. It was also the most significant gathering of world leaders ever. Throughout the Rio Conference, disputes raged over finance, control, and the relative significance of consumption rates and population (Timberlake, 1995).

Over the following decade, emissions of greenhouse gases are expected to rise by about 14% under these pledges. Every industry must promptly and significantly cut its emissions if we are to avoid a climate disaster and progress toward a sustainable future. In 2020, atmospheric new record highs in greenhouse gas concentrations all-time high, and ongoing trends are shown by real-time statistics. The global average temperature rises in tandem along these lines of attention. This year ranks as one of the seven warmest on record. (2015-2020), the average worldwide temperature in 2021 was rise of 1.11, or 0.13 °C, over the pre-industrial average (1850-1900). While seasonal and yearly temperature shifts across the world are a given, the long-term trend is one of warming. Extreme weather events are becoming more common as global temperatures continue to climb. This leads to record-breaking temperatures in Canada, disaster-causing floods in Europe and Asia, and food scarcity in portions of Africa and South America, as well as other potentially catastrophic catastrophes. The global annual mean temperature is expected to soar over 1.5 °C one of the following five years will see an increase above pre-industrial levels, dangerously close to the lower objective of the Paris Agreement (SDG Indicators).

According to the IPCC report for 2023, the global average Increasing heat levels by 1.1 the Celsius scale (2.0 degrees Fahrenheit), and environmental shifts that are unprecedented over centuries or every part of the world is experiencing a millennium, including researcher may expect higher sea levels and more severe weather., and rapidly melting sea ice is a summary of additional global warming evidence.

Increasingly hot weather over the world increases the likelihood of reaching hazardous climate system tipping points, which, once crossed over, can activate self-reinforcing loops that amplify climate change, including the thawing of glaciers or the death of vast expanses of forests. Initiating such reinforcing feedback can also result in other significant, abrupt, and irreversible alterations to the climate system. One of the most alarming findings of AR6 (IPCC 2023) is that there are already more negative effects on ED pervasive and severe than anticipated. Half of the worldwide human being experiences severe water shortages for at least one month per year, and rising temperatures are facilitating vector-borne disease transmission like malaria, West Nile virus, and Lyme disease are a grave concern. Since 1961, climate change has delayed crop productivity increases in Africa by one-third. Since 2008, severe flooding and cyclones have displaced more than 20 million people yearly (Boehm & Schumer, 2023).

Currently, between 3,300,000,000 and 3,600,000,000 reside in countries extremely vulnerable to climate impacts. The regions of the world (the Arctic, South America, and the Island Developing States of Asia and the Pacific), and a massive portion of sub-Saharan Africa. In many nations of these areas, where strife, inequality, and development difficulties are all too familiar (such as poverty and limited access to essential services such as pure water) increase our awareness of climate risks and their impact, but also the adaptability of local communities. From 2010 to 2020, death from cyclones, nations with high sensitivity to climate change saw 15 times more severe weather events like floods and droughts than countries with exceptionally low vulnerability. Climate change mitigation efforts risk causing disruptive changes and aggravating inequity. Decommissioning as an example, coal-fired power facilities have the potential to displace employees and damage local economies and alter the social fabric of communities. At the same time, ineffective efforts to halt deforestation can worsen poverty and food insecurity. Moreover, specific carbon prices and other climate initiatives which raise the price of emissions-intensive products like petroleum, can also be regressive if there are no efforts to reinvest the tax revenues in programs that benefit low-income communities (AR6 IPCC Intergovernmental Panel on Climate Change, 2023).

Despite adopting seventeen (17) Sustainable Development Goals (SDGs), the zero-carbon objective seems unlikely to be possible in the near future. Lots of countries and international projects are taking steps to protect themselves from potential economic losses brought on by the external expenses associated with climate change when they're not equipped for adverse effects such as extreme weather, natural disasters, and other outcomes (Giro et al., 2019). To assist countries in coping with ED, international initiatives like the Conference of the Parties (COP) have advocated the Sustainable Development Goals (SDGs). Around 200 nations vowed to join the Climate Pact and cut global carbon emissions at COP26. SDGs are necessary for countries to advance toward a more ecologically friendly future because of the unfavorable impacts of pollution on human health, agriculture, and businesses. Retooling manufacturing to utilize green energy is one of the SDGs (Farzanegan & Parvari, 2014).

Nevertheless, challenges still stand in the way of achieving net-zero emission goals, most of which are connected to the development of innovative green technology. Not only do required technologies need widespread proof of concept, but vast sums of private investment are needed to implement them. Because of a lack of support from the corporate sector, countries are finding it difficult to move to green energy.

Considering the environmental dangers of recent decades, steps must be taken to cut back on carbon dioxide released during production greenhouse gases if humanity is to have any hope of maintaining a pleasant aspect of life. The health implications of climate change are intricately tied to global development policies and health equality concerns. The people who have the least access to the world's resources and have contributed the least to its cause are impacted by climate change. Climate change should catalyze achieving the targets set by the MDGs and accelerating development in one among the poorest nations. Additionally, climate change highlights the question of intergenerational equity. Without prevention and adaptation, it will exacerbate health disparities through adverse impacts on the socioeconomic lifestyle factors in the most disadvantaged populations. The inequality of climate change, with the wealthy producing most of the issue and the poor first enduring most of the repercussions, will cause historical shame for our time (Human Development, 2022).

From 2016 to 2020, the world's maternal mortality ratio showed no change, with an annualized rate of change of -0.04 percent (UI: -1.6-1.1 percent). However, this trend has not been sustained in the Sustainable Development Goals (SDGs) era. In 2020, an estimated 287 000 women died. Many deaths related to pregnancy and childbirth can be prevented. This equates to approximately 800 women per day, or 223 deaths per 100 000 live births (World Health, 2023). Using data compiled by the UN Inter-agency Committee for Child Mortality Estimation, the Promise Revisited Progress Report 2014 reaffirms the considerable progress made in enhancing child survival. The global infant mortality rate has decreased by nearly half, from 90 fatalities per 1,000 live in 1990 the rate of births was 46 per 1,000, while the rate of deaths was also 46 per 1,000 by 2013.

The significant decrease in preventable infant fatalities over the last 25 years is among the most pivotal in human history human accomplishments while in 1990, 12.7 million children under age five perished. This number decreased to 6,3 million in 2013, a decrease of approximately 50 percent. In 2013, 17,000 fewer children perished daily than in 1990 because of better and cheaper medical care, innovative research methods providing life-saving care to those in need impoverished, omitted, and unwavering political dedication. The global decline in infant mortality is remarkable. The number of newborns who perished within the first 28 days of infant lives decreased from 4.7 million in 1990 to 2.8 million in 2013 (Wardlaw et al., 2014).

It is critical to prevent unintended pregnancies to reduce maternal mortality. All women, including adolescents, must having easy access to birth control, legal and secure access to safe and effective abortion care and aftercare. This report discusses contraception coverage in the universal health coverage (UHC) section. However, these objectives are not being met at the expected rate. Comprehension of anthropogenies, or the effects of humans on the environment, requires a comprehension of finance, but little has been done to incorporate environmental concerns into finance.

Sustainable development is explained by the International Panel on environmental degradation for the first time as a development that satisfies the current requirements of people without endangering future generations' ability to meet their own needs. Evaluations of energy sustainability contemplate the role of energy's negative externalities. Emerging severe ecological problems and the energy crisis threaten the capacity of human society to evolve sustainably. The international community has proposed sustainable development objectives (SDGs). Between 2021 and 2030, a global ARR of 11.6% is required to meet the SDG target. This rate has yet to be attained nationally over an extended period.

Financial development is necessary because it provides financial resources linked to environmental and economic sustainability (Aljadani, 2022). Long-term economic expansion can be facilitated by financial institutions lending to private investors. A credible financial institution can help support renewable energy initiatives, as financial intermediation is critical for increasing sustainable development (Islam et al., 2022). Energy consumption and institutional quality are significantly impacted by financial growth, which reduces energy consumption. Additionally, a stable financial system facilitates access to financial resources, which raises living standards and stimulates economic growth. A development of innovative and useful technology is aided by the aforementioned financial framework and the availability of financial resources that are more environmentally friendly and environmentally sustainable, thereby reducing pollution issues (Irfan et al., 2022).

Additionally, growth in the financial sector and deregulation of the capital market promote business ties, encourage technological departments to pass on green technology, and facilitate research and development in the host nation. Theoretical research has provided several reasons why financial development is necessary to combat ED. For instance, financial development facilitates private and public sector investors' participation in renewable energy projects, reduces risk diversification, and reduces intermediary costs (Nasir et al., 2019). Foreign investment in highly industrialized nations has been primarily driven by trade liberalization. According to research presented by (Ren et al., 2022), its significance as a source of new wealth in these nations has increased. To sustain the world's projected 9 billion people by 2040, conventional agriculture would need to increase by an estimated 35%. This would increase agricultural greenhouse gas emissions, which account for a minor portion of the total (H. Zhao et al., 2022).

To keep global warming below 2°C by 2060, greenhouse gas emissions must account for 50 percent of all emissions. These effects on the ecosystem may significantly impede efforts to conserve resources and reduce global warming. Similarly, natural resources are crucial to the economics of developing countries. These nations' economies are based on exploiting their abundant natural resources (Iqbal et al., 2021).

Financial strength refers to the stability related to the economy's foremost financial institutions and markets. FS, is essential as it boosts trust in the economy and encourages sponsors, depositors, and consumers to provide the funds that would otherwise be channeled to deficit units (Elsayed et al., 2023). While most of the previous research has focused on the impact of effects of climate change and other climatic hazards on FS and other sustainable development risks, more attention needs to be devoted to the role of liquidity in achieving sustainable development. Consequently, financial stability contributes to achieving sustainable development objectives (Elnahass et al., 2022).

Theoretically, a secure economic and financial uncontrolled environment may encourage more investment and production of nonrenewable energy sources setting, thereby increasing CO_2 emissions and energy consumption. By discouraging or promoting greater transparency regarding methods, existing items, and instruments used about market involvement, financial regulators, and the financial markets undermine or enhance confidence, integrity, and market practices. This could be accomplished by encouraging the reallocation of capital towards sustainable options while discouraging the reallocation of capital towards carbon-intensive and the other way around, too. Furthermore, it might enhance investigation and creation (R&D), sustainable inventions, and cutting-edge technology by accelerating the method of technological advancement with financial assistance. A mediating impact connecting risk of financial loss and CO_2 emissions is the key finding of this research. In layman's words, when financial risk is increased, it has two effects on the world's carbon dioxide emissions: it either decreases emissions directly or indirectly through its influence on technological innovation. Furthermore, a large U-shaped connection exists between financial risk and CO_2 emissions throughout the world (J. Zhao et al., 2021a).

Green growth is an alternative variant of environmentally and socially responsible economic growth. It's a perfect example of the "triple bottom line", which promotes economic, environmental, and social sustainability. The theory of growth-driven finance, this study proposes that green growth is the primary driver of FS because, in addition to equally concerning as economic expansion, environmental danger, and social stratification is significant variables that challenge financial stability. Green growth is a commercial strategy to accomplish this objective. In addition, green development emphasizes economic growth by placing public and private investments based on enhanced sustainable practices in the workplace (Jadoon et al., 2021). In the modern world, securing sustainable economic growth through the administration of green growth and carbon reduction of economies has become a top priority. Decoupling economic development from carbon emissions is a crucial policy goal and a pressing concern for the global economy. Green development is the concept of attaining economic growth in an environmentally friendly and sustainable manner. It seeks to separate economic expansion from the exhaustion of natural resources and deterioration of the environment, promoting resource efficiency, innovation, and capital for carbon-reducing systems and tools (Loiseau et al., 2016; Sohail et al., 2022).

According to the SDG No. 13 stats, CO_2 emissions increased by Six Percent in 2021, the highest ever, due to the global temperature rising unabatedly and more extreme weather. The other aspect of this rise in CO_2 emission may be that the stat shows that the world has fallen short of 100 billion dollars of the target of sustainable development Goal No. 13. Innovation is a vital component of climate change policy in many areas. Innovation suits the interests of large polluters in the energy sector. It supports long-term growth rhetoric that disregards natural limitations to economic expansion when it is reduced to technological innovation and related to market-based top priorities (Adkin, 2019).

Discovering the inconsistencies and dynamics of global warming would aid in combating the environmental threats caused by climate change, and the importance of adopting appropriate innovative technology should be emphasized as a potential means of achieving this objective. The progression and effects of climate change are attributable to human activities. Climate change mitigation and management are possible with dependable instruments and continuous measurements and analysis mechanisms. If management is ruled out, humanity will be forced to confront the impending cruelty that its actions and inactions will indirectly impose. This demonstrates the relevance of contemporary technology. Numerous economic sectors' persistent demand for accurate, specialized meteorological forecasts has led to the continued expansion of meteorological industries, mainly private meteorological forecasting services in many developed nations. a) Creating measuring and monitoring instruments for meteorological and thermodynamic variables. b) Improved communication methods for collecting meteorological data and transmitting forecasts correspondingly. c) The use of balloons, aircraft, missiles, and satellites for investigating climatological conditions in the lower and higher atmosphere and transmitting this information to the Earth. Utilization of high-speed computers for monitoring, processing, and analyzing enormous amounts of acquired meteorological data. Big data analytics has a great deal of application in this field (Nwankwo et al., 2020).

Direct investors employ a variety of resources made possible by technological advances, which have a significant impact on energy intensity. They take several other measures that may indirectly affect green financing, such as encouraging industrialization, trade liberalization, economic development, and so on (C.-H. Yu et al., 2021). Thus, innovations occasionally raise sustainability worries by highlighting the contentious relationship between modern innovation and the environment. Even though technological innovation is essential for the survival of businesses and economic growth, it also poses environmental challenges critical to sustainable growth and development (D. Wang & Chege, 2020). Nevertheless, the level of scientific development may alter the direct or indirect effects of green financing (C.-H. Yu et al., 2021).

When innovation in the economy is poor, the financial industry might need more energy-efficient consumer goods. However, if technology progresses robust, consumers and businesses can access various energy-hungry goods and have new opportunities to utilize enormous machines contributing to green financing. Energy consumption can be reduced thanks to technological developments that make resources for manufactured items and machinery available to consumers and businesses (Sarkaya & Güllü, 2015). The growth of the financial sector has called for a robust banking industry.

Solar and wind energy costs have significantly decreased over the past ten years because of technological advancements, making renewable energy sources more affordable than fossil fuels. By 2050, it is predicted that relying less on fossil fuels and more on renewable sources of energy enable economies worldwide to save $12 trillion (World Economic Forum, 2023). These conventional energy sources account for most greenhouse gas emissions. Furthermore, it has been discovered that conventional non-renewable energy sources are more expensive than green energy, which is more cost-effective. Increasing the use of non-renewable energy may also increase greenhouse gas concentrations. The United Nations Sustainable Development Goals recommend switching to renewable energy sources. Despite the increase in renewable energy production, there is still a significant reliance depending heavily on fossil fuels for power production, according to the Renewable Energy Global Stats 2022 Report by REN21. The transition to renewable energy is occurring gradually. Global leaders should seriously consider the findings of the report, especially those in Asia, given the severity of the climate crisis.

According to the 2020 SDG report, approximately three-quarters of carbon dioxide (CO_2) emissions are still associated with energy production, even though renewable energy accounts for only 12.65% of total energy consumption. To reduce CO_2 emissions, countries reached an accord at the UN climate sum progressively to reduce the use of unabated coal power. This pledge was made by 135 nations, which collectively account for 88% of global emissions. From 2009 to 2019, the demand for final energy increased by 19%. Incredibly, fossil fuel subsidies in 2020 amounted to an astounding USD 5.9 trillion, or 11 million USD per minute.

In contrast, renewable energy investments in 2021 total USD 366 billion. In 2023, governments and top business figures will concentrate on expanding green technology and creating new ones. Green hydrogen is a clean energy source that captures renewable energy from places with plenty of wind or solar power and ships it to places where it's desperately needed.

Following the recent proof of concept that it can produce more energy than is necessary to initiate the fusion process, nuclear fusion is another green technology to watch in 2023. These most recent findings will encourage more research to advance the technology, bringing us closer to a day when nuclear fusion might supply nearly infinite, secure, and clean energy, even if we are still years away from producing energy at scale.

Green finance can promote moving from NREC sources to green energy 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. World leaders should hear the report's conclusions, especially those in Asia, considering the escalating climate issue.

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%.

In the report, it is claimed that the time of inexpensive natural gas is over the most significant increases in energy prices since this caused the 1973 oil emergency. Almost all 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 -New Global Status Report, 2022). The effect is that There is a severe lack of renewable energy sources, and fossil fuels are no longer affordable. With high electricity prices and unstable supplies, this is the ideal process for an energy issue. They need a sensible renewable energy program. More renewable energy sources must be utilized to cut down on emissions of greenhouse gases. However, investors initially view renewable energy projects as high-risk, low-return ventures, making it difficult to secure funding (Noh, 2019). However, investment in renewable energy sources has dropped significantly due to improvements in environmentally friendly technology and the decreased rate of finance offered by green financing (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 & Raimondi, 2020). Private-sector financing is the only means to replace your use of fossil fuels with renewable energy. According to (Pathania & Bose, 2014), financial means and innovation have been the main factors behind every significant energy shift in history, including the shift to renewable energy sources. They also emphasize the significance of technological advancements but the importance of financial triumphs in starting the energy transition. However, many nations need help moving 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 RE sources on board, despite the high original expenditure, to cope with energy market volatility. Therefore, increasing renewable energy production capacity is essential for the sake of preserving the planet from the ravages of climate change. With this in mind, it is essential to identify the causes that can promote renewable energy advancement and reduce the global reliance on fossil fuels to achieve SDG-13's climate change objectives (Abolhosseini & Heshmati, 2014).

It is commonly believed that insufficient funding is the primary impediment to the green transformation of global energy systems. Significantly the large initial expenditure required to create the necessary technology for generating power from renewable sources is a major deterrent to the funding of renewable energy development projects, thereby increasing fossil fuel reliance and lowering renewable energy utilization rates. Focusing on the issue of climate change mitigation, increasing research and development expenditures geared toward the expansion of renewable energy sources will stimulate global environmental quality improvement. In addition, the significance of domestic revenue mobilization for the development of renewable energy, particularly for mitigating climate change-causing factors, has been acknowledged in numerous studies (Taghizadeh-Hesary & Yoshino, 2020).

There is a connection between SDG-7, which aims to increase the share of renewables in the global energy mix, and SDG-13, which aims to address some of the utmost basic climate change-related objectives. One major objective of SDG 13 is to "integrate climate change measures into national policies, strategies, and planning" (Target 13.2). This objective can be met, for instance, by combining the promotion of renewable energy production with national initiatives for economic expansion. In this light, it may be deemed essential to realize Sustainable Development Goal 7's "promoting investment in the development of energy infrastructure and clean energy technological advances" and "expanding infrastructure and upgrading technology for providing modern and environmentally sustainable (clean and renewable) electric power (Targets 7. and 7. B)" objectives. Therefore, increasing funding for the creation of infrastructure associated with renewable energy sources is likely to function as a viable action plan for boosting resilience against various tragedies connected to climate change.

1.3 Problem Identification and Problem Statement

Globalization, population development, and the rapid expansion of economic activity have all contributed to increased CO_2 and other greenhouse gas emissions, putting the ecosystem in grave danger (Kirikkaleli et al., 2021). Due to the enormous energy demand, the continued growth of the world economy, which averages 3 to 4% annually, puts a serious threat to environmental sustainability. CO_2 emissions are positively impacted by financial development, when industry increases, and money is created by increasing risk diversification, which influences CO_2 emissions, financial expansion negatively affected by environmental deterioration (Sadorsky, 2010). These elements contribute to a 4-6^{oC} increase in temperature. The earth's temperature has risen by 1.9 degrees Fahrenheit over the past 50 years due to the total CO_2 particle concentration reaching 413 parts per million in the air (Greicius, 2022).

There have been various factors identified that contribute to environmental dilapidation, income, industrialization, global trade, urbanization, deforestation, population growth, and energy consumption are the most frequently highlighted factors contributing to environmental deterioration and neglecting greenhouse gas emissions in favor of a more favorable economic condition (Khan et al., 2020). From 25,715.7 million tons of CO_2 in 2003 to 33,890.8 million tons of CO_2 in 2018, global CO_2 emissions increased by 31.79%. CO_2 emissions, as the main element of greenhouse gases (GHGs), pose a severe threat to the ecosystem. The steady greenhouse gas emissions have increased, which has led to many environmental and societal challenges, such as rising sea levels, deforestation, and glacier melting, all of which may have devastating effects on the development of human society (United Nations Report 2022).

The issue is that due to the rapid expansion of the global economy, population growth, and globalization, CO_2 and other greenhouse gas emissions have increased significantly, posing a grave environmental threat. Several factors, including income, industrialization, international trade, urbanization, deforestation, population, and energy consumption, have been identified as determinants of environmental degradation. However, due to a focus on financial considerations, greenhouse gas emissions are frequently overlooked. Numerous environmental and societal challenges, such as rising sea levels, desertification, and dissolving glaciers, have resulted from the escalating greenhouse effect, which can devastate human society. The United Nations recommends switching to renewable energy as a superior alternative for cutting down on carbon dioxide emissions.

"*The factors identified by the researchers which can contribute or mitigate the issue of climate change and energy are yet to be explored in scientific manner through data. This study particularly addresses the issue of country level financial risk and sustainable development. As mentioned, the climate change effects human, livestock and the natural habitat, this study presents the issue of climate change in special reference to greenhouse gases emission and financial risk.*"

1.4 Research Gap

Existing research has predominantly focused on calculating the green growth index for OECD countries using the entropy-weighted method. Extending this analysis to a broader spectrum of countries, such as both OECD and non-OECD nations, is a research gap. This study will use the financial risk as independent variable, used as mediator previously. In model-2 financial risk is used as dependent to examine other factors impact. In addition, there needs to be more research on the effects of green development on greenhouse gas emissions, financial risk, and key economic factors such as technological innovation in renewable energy, financial inclusion, and soft infrastructure.

1.5 Research Question

Q1: How do financial risk and global greenhouse gases emission affect each other?

Q2. How can green growth change the financial risk situation and greenhouse gases emission?

Q3. How can technological innovation change the financial risk situation and Greenhouse gases emission?

Q4. How will financial inclusion affect financial risk and global greenhouse gases?

Q5. How can renewable energy minimize financial risk and global greenhouse gas emissions?

Q6. How will soft infrastructure change financial risk at the country level and global greenhouse gases emission?

1.6 Research Objectives

This research delves into the contribution of green growth and other economic indicators in promoting financial risk and Environmental Sustainability. However, this study also surveys the value of new technologies financial inclusion, green power, and soft infrastructure in enhancing sustainability and helping achieve SGDs in terms of climate change effectively. As the UN report revealed that CO_2 emission is increasing every year and the world is failing to achieve green growth, this study aims to explore this issue and give policy recommendations to minimize greenhouse gas emissions to achieve the targets set by the UN. Secondly, it is seen that developing countries face worse financial situation day by day. Financial risk government should have focused on something other than greenhouse gas emissions; they want to achieve their financial target, which causes environmental degradation. Private sectors must invest in a financially stable situation project as it should be. So, this study will explore how Improvements in the can be made through green growth and economic indicators financial risk situation.

Objectives are listed below:

1. Assess the impact of global greenhouse gas concentrations and rising temperatures on extreme weather events and their implications for vulnerable regions.

2. Investigate the progress and challenges of international initiatives like COP and SDGs in achieving net-zero emissions and promoting innovative green technology.

3. Analyze the health, development, and inequality implications of climate change, and identify strategies for comprehensive financial development to resolve environmental issues and promote long-term economic growth.

4. Evaluate the effectiveness of green growth approaches in achieving economic, environmental, and social sustainability in the face of climate change.

5. Examine the advancements in renewable energy technologies and their potential to combat climate change, considering their cost-effectiveness and impact on reducing fossil fuel reliance.

6. Provide policy recommendations for governments and institutions to integrate climate change measures, promote renewable energy investment, and achieve financial risk targets and sustainable development goals set by the UN.

1.7 Significance of Study

This study will give a policy recommendation to the government in structuring the green financial scheme and green fund, which can help promote the sustainable development goal in terms of climate change and green growth. At the institutional level government should increase the fund for the private sector and regulate these funds toward green growth and technological innovation projects, which can be helpful in environmental sustainability. This study also opens the scope of the effect of synthetic carbon dioxide emissions on financial risk and vice versa. Renewable energy consumption affects greenhouse gas and financial risk with technological innovation. The findings of this research will provide policymakers with invaluable guidance on how to structure efficient green financial mechanisms and assign funds for sustainable development projects. It will also contribute to our comprehension of the intricate interplay between greenhouse gas emissions, financial risk, consumption of renewable energy, and technological innovation.

1.8 Practical Implications

The study will help policymakers in combating climate change. The findings of this study suggest that policymakers reshape the policies related to greenhouse gas. The results suggest that the government to give incentives to the institutions in the field of alternative energy to institutions should shift toward renewable energy and contribute to improving environmental quality. Government can develop policies and regulate the fund toward sustainable development, which can be helpful in environmental sustainability. At the institutional level government can promote financial development. As a result of this study suggested that with the promotion of financial development, renewable energy consumption can be increased. This study also explores the direct effect between greenhouse gas emissions and financial risk. Further researchers can look toward moderators like governance and corruption in future studies.

1.9 Summary

In 2020, the concentration of greenhouse gases throughout the world hit a record level, leading to a 1.1-degree Celsius rise in global average temperature. Extreme weather events became more common, impacting various regions. The global mean temperature is expected to dangerously approach the Paris Agreement's lower objective. Around 3.3 to 3.6 billion people live in vulnerable countries, facing challenges in adapting to climate change. Initiatives like COP and SDGs aim to tackle climate change, but achieving net-zero emissions remains challenging due to the need for innovative green technology. Climate change affects health, development, and inequality, necessitating comprehensive financial development for sustainability. Green growth, focusing on economic, environmental, and social aspects, is crucial. Renewable energy advancements can combat climate change and save trillions by 2050. However, fossil fuels still dominate CO_2 emissions. Financing renewable energy is essential for transitioning away from fossil fuels. SDG-13 aims to integrate climate change measures and promote renewable energy investment for economic growth. A study on green growth's impact on greenhouse gas emissions and financial risk can offer policy recommendations for sustainable development goals. Governments can foster economic growth and alternative energy consumption to combat climate change. The study examines the link between greenhouse gases emissions, financial risk, and factors like green growth, technology innovation, renewable energy, financial inclusion, soft infrastructure.

Chapter 2

Literature Review

2.1 Introduction

Sustainable development and a transition towards renewable energy sources have become indispensable to addressing global environmental challenges. As the international community grapples with the need for environmentally sustainable economic growth, academics and officials have focused on understanding the intricate relationships between sustainable development, renewable energy, and several independent variables. This literature chapter provides a comprehensive review and synthesis of existing scholarly works examining the relationships between sustainable development, financial risk, and vital independent variables such as green growth, technological innovation, and financial inclusion soft infrastructure. This chapter aims to shed light on the current understanding of these relationships by investigating the existing body of knowledge, identifying research voids, and establishing the foundation for the empirical investigation conducted in this MPhil dissertation.

2.2 Dependent Variable-literature Review

This portion provides a comprehensive literature review of sustainable development and Financial Risk 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 financial Stability.

2.2.1 Sustainable Development (Greenhouse gas emissions)

Global warming has become a major issue global issue (J. 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 (Lebkowski, 2019). GHG is the primary cause of global warming and air pollution. Increasing conveyance volumes have a more significant detrimental effect on the quality of 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). They are emitted by numerous human activities, such as industrial and transportation activities (Sinha et al., 2020). Greenhouse gases (GHGs) have been produced at a higher rate by human activities since the industrial age began. The amount of energy that greenhouse gases add or subtract from the Earth's atmosphere is called their radiative forcing, and it is measured in watts per square meter (W m2). (IPCC,1996). Radiative forcing (how much of an impact the addition of a unit of gas is expected to have on Earth's energy balance), mean lifetime (how long the forcing by a unit of gas is anticipated to last), and emissions (how much gas is emitted) are the three components that make up the climate forcing potential (GWP) or climate change potential (CCP). We only count the first two as GWP. Gases such as ozone (O_3), methane (CH_4), nitrous oxide (N_2O), and CO_2, N_2O, are all examples of naturally occurring greenhouse gases that trap heat. Hydrofluorocarbons, perfluorocarbons, and sulfa Sulphur hexafluorides are all examples of man-made greenhouse gases. (IPCC, 1996). Carbon dioxide, methane, and nitrous oxide are three greenhouse gases that contribute to climate change. Principal contributors to positive increases in radiative forces (IPCC 1996).

By the 2100s, the CO_2 level is expected to have risen to 500 ppm. According to the IPCC, by 1992, full of atmosphere concentrations of both CH_4 and N_2O had grown by 15 percent from pre-industrial periods (IPCC, 1996). After an evident decrease in CH_4 emissions during the 1990s, anthropogenic CH_4 emissions have risen again (Bousquet et al., 2006). Between 1979 and 2004, the N_2O concentration increased linearly (Kandel et al., 2019). Additionally, livestock contributes to the increase in GHG emissions. Although the dynamic contrast of climate interactions is not fully understood, there is widespread scientific agreement that human activities contribute to global climate change. 2001, Houghton et al. Since the UN's MDGs were established in 2000, economies have focused on regulating GHG emissions regardless of their development status. Because industrialized nations and countries with an industrial orientation impact the environment, they must regulate their emissions. Subsequently the inauguration of SDGs 2015, however, world-leading agencies and UN a more member states observed concentrated and attentive approach to environmental purification and protection (Schaeffer et al., 2015; Skrúcanỳ et al., 2019). They have analyzed the diverse policy implications and their impacts on European nations. They demonstrated that prudent sustainability requires policies regardless of the state's level of development.

Other research (Sinha et al., 2020) assessed technology's influence and government initiatives on GHGs in the environment of a minor sample of Asian and African economies. They determined that nations have focused more on their sustainability and SDG achievement policy mechanisms. Since the inauguration of the SDGs, academics have evaluated the state policy implications of a concentrated approach and suggested various policy implications for achieving all SDGs through optimal state resource utilization (Pezzagno et al., 2020). Global climate change's predicted and observed effects include rising sea levels (Shepherd & Wingham, 2007), rainfall distribution changes, and storm intensification (AR4 IPCC Climate Change, 2007). and an accelerated rate of species extinction. Current strategies for combating global warming fall into two broad groups: (1) reducing fossil fuel combustion and other GHG emissions and (2) increasing carbon sequestration (Grady et al., 2001). However, some authors have also identified financial vulnerability as crucial in determining sustainable development.

Theoretically, Because of the information asymmetry it creates, financial instability can reduce environmental quality because it makes it difficult for financial institutions to fund renewable energy projects. In a similar vein, FDI flows are harmed by financial sector instability (FDI), which impedes the introduction of environmental innovations into the economy, thereby degrading environmental quality (A. Baloch et al., 2022; B. Yang et al., 2022).

The features of adaptation as well as mitigation have a significant impact on the ability to assess the fiscal and monetary implications of climate change. Conditions under which climatic shocks may escalate and persist are affected by these elements and the design of shock scenarios. A increasing body of literature highlights the shortcomings of traditional approaches to assessing the macroeconomic and financial impacts of global warming and climate policy. (Chang et al., 2022; Dilanchiev & Taktakishvili, 2022).

H1: Financial risk significantly impacts greenhouse gas emissions and climate change.

2.2.2 Financial Stability/Financial Risk

The danger of losing money in a business Endeavor or investment is known as financial risk. The inability to manage the government's money supply and other debt issues is a financial risk. Explore the numerous facets of financial risk and its implications for businesses, governments, markets, and people. Financial stability is vital for economic development and impacts environmental quality (Lee; Chiu 2013; Shahbaz 2022). First, a more secure financial environment supported by robust financial institutions may entice more FDI, resulting in higher economic growth., increasing energy consumption. (Lee; Chiu 2013; Shahbaz 2022.)

To begin, green structural transformation necessitates substantial expenditures in high-capital-cost areas like Innovation and clean power (Lindenberg, 2014). These industries are very susceptible to uncertainty and risk. Low-carbon energy sources, such as renewables, would require investment if green transition scenarios are to be met quadruple, creating a "green finance gap (Bui, 2020). On the other hand, the study uses long-term equilibrium to examine the connection between carbon emissions, economic growth, and energy use. The study found that rising GDP directly increases CO_2 emissions and energy demand, worsening India's already poor climate. (Boutabba, 2014). In other words, insufficient financial resources for green investments threaten the financial system's stability. Moreover, investing practices, accounting systems, and financial regulatory regimes are being shown to have an intrinsic “carbon bias" (Campiglio, 2016). Besides, this study showed that FR does not affect emissions (Ozturk & Acaravci, 2016). Studies have revealed that climate-improvement efforts may have an unanticipated effect on the financial system's stability (Battiston et al., 2017; Dietz et al., 2016; D’Orazio & Popoyan, 2019).

Examined the non-linear impact of financial Risk on CO_2 emissions using the penal smooth transition regression model, and the results showed a negative impact between Financial Risk and CO_2 emissions. Furthermore, the studies found the same results (Shahbaz et al., 2017) and (Abbasi & Riaz, 2016) and (Zaidi et al., 2019a). Boutabba's finding was revised and confirmed by (Bui, 2020) and (Fang et al., 2020). Acheampong looked at the direct and indirect impacts of economic growth on carbon dioxide emissions, analyzing data from Between the years of 2000 and 2015, 46 nations in sub-Saharan Africa. Findings from this research indicate that economic growth directly impacts CO_2 emissions and suggests that they may differ across other economic development indicators (Acheampong, 2019). Researchers urged Increasing economic activity dampens carbon emissions.

Financial development considerably reduces both long- and short-term carbon emissions, according to an analysis of panel data covering APEC nations from 1990 to 2016 (Zaidi et al., 2019b). Meanwhile, the Umar study discovered a persistent inverse relationship between CO_2 emissions and China's economic growth (Umar et al., 2020). Mberak testified that financial development has an adverse influence on carbon emissions over the long run, showing that economic growth reduces environmental damage (Kais 2017). Previous study findings were consistent with those (Kirikkaleli & Adebayo, 2021).

Report negative interrelationship between Financials risk and Carbon dioxide emission on the other side, other studies showed that FR worsened CO_2 emissions. For example, the study by (J. Zhao et al., 2021b). These emissions endanger human existence. Therefore, decreasing carbon emissions to prevent The occurrence of natural disasters on a worldwide scale has priority (Acosta et al., 2020). Theoretically, it is reasonable to predict that a solid financial and economic position will improve environmental quality, boost spending and manufacturing in nonrenewable power plants in an unlawful carbon dioxide emissions and energy costs in the environment consumption to a certain extent. Market perception and the economic coordinating authority could weaken or boost market confidence, trust, and activity by reducing or rewarding greater openness regarding the current financial market processes, goods, and instruments. This was accomplished by relocating cash towards greener solutions and discouraging capital reallocation to carbon-intensive initiatives. By providing subsidies and incentives to boost R&D, it will be possible to accelerate the adoption of clean technology and significantly reduce CO_2 emissions (J. Zhao et al., 2021b).

Economic instability also enhanced people's desire to live better life resulting in CO_2 emissions being efficiently decreased (Song et al., 2021). As a result, the potential for carbon assets to become worthless in a post-carbon economy increases and the financial sector is less likely to align with sustainable transition roadmaps (Chevallier et al., 2021). Numerous studies have examined the connection between economic growth and carbon emissions to better understand the two concepts. There is still no agreement among academics over the findings. Some academics have claimed that a flourishing economy has a favorable effect on greenhouse gas emissions. For instance, Shen used a cross-sectional expanded auto regression distribution lag (CS-ARDL) approach for examining how economic expansion affects efforts to lower carbon emissions in 30 different provinces across China. The study found that as the economy developed, carbon emissions increased (Shen et al., 2021).

The researcher worked on different features of finances on CO_2 emissions, containing financial proficiency (Köksal et al., 2021), economic expansion (Paramati et al., 2021), along with the development of financial technology (FINTECH) (Croutzet & Dabbous, 2021). Innovations in technology and the ongoing expansion in terms of usage of renewable energy might influence FR, influencing carbon dioxide absorption. These studies shed light on the connection between FR, R&D, RE, and carbon emissions. Conversely, the research is incomplete. Prior research has focused on the effect of economic growth on carbon emissions, but just a handful of studies have examined the affiliation between financial stability and CO_2, particularly for OECD nations. Second, prior research suggests that R&D spending and renewable energy may significantly impact the energy consumption-economic growth nexus. But most studies have focused on R&D and renewable energy-related carbon emissions. The relationship between financial risk and carbon emissions is not widely studied, and neither is the influence of budgets for studies nor renewable energy. Finally, the influence of financial risk on carbon emissions has been studied, but the non-linear consequences have not (Q. Wang & Dong, 2022). As the economy has grown outdated, more polluting technologies have been gradually phased out in favor of newer, greener ones, improving environmental quality. Modifications to product structure facilitate the separation of economic growth and environmental degradation, the development of more eco-friendly industrial technology, increased environmental legislation, and heightened environmental consciousness (Raihan 2022:)

Limiting energy use is a popular policy initiative among governments worldwide. This dependence raises concerns about the environmental effects of using fossil fuels. Complex social and technical processes as well as societal and technological consequences may shape these actions. In a similar vein, globalization's contribution to healthier environmental conditions through improved nuclear power production technologies is noteworthy. Adopting growth-promoting policies often increases government income, but at the price of an increase in EFP; economic expansion drives up energy use, which in turn raises EFP and contributes to environmental detriment (Ahmed:2021). Global energy systems must utilize low-carbon energy and technologies to reduce the global ecological impact. While nuclear energy remains highly controversial, especially among environmental activists, some have suggested reconsidering it as a source of pure energy to combat climate change (Hassan et al., 2023). In pursuit of rapid economic development, however, world economies have compromised natural capital, leading to major environmental issues such as the extraction of energy resources, the loss of biodiversity, land degradation, and air and water contamination (Hassan et al., 2023).

H2: Greenhouse gas emissions have a significant impact on financial risk.

2.3 Independent Variable Literature Review

The following is a comprehensive literature review of the independent variables. Specifically, this study investigates existing research on green growth, renewable energy, technological innovation, financial inclusion, and soft infrastructure. This study seeks to shed light on the significance of these variables.

2.3.1 Green Growth

As opposed to sustainability, green growth promotes ecologically sustainable growth without lowering the fiscal growth rate. As a result, green growth is regarded as a successful low-carbon framework and a viable road toward sustainable development (G20 2019; UN. et al., 2012). Because green growth comprises both short-term economic growth and long-term environmental sustainability, multi-sectoral activities are required the consolidation of new resources through investment and innovation while stimulating economic growth (Huang & Quibria, 2013; *OECD:* Green Growth 2022). To that aim, green growth, defined as an alternative growth route requiring policy instruments such as fiscal and monetary policies, has emerged as a critical issue for the international community, spurring significant research into its causes (Jason Hickel 2019; Kim et al., 2014; Zhao, Shahbaz, et al., 2022). Because green growth is a viable method of achieving sustainable development, many scholars have committed their efforts to an in-depth investigation of the relationship between green growth and its driving elements, such as technological innovation (Mensah et al., 2019; K.-H. Wang et al., 2021; J. Zhao et al., 2021b). High financial risks will also stymie the rise of national direct and indirect investment, stifling the country's economic progress. On the other hand, scholars have confirmed that financial risks can harm environmental quality, which adds to research on how financial risks affect green growth.

Many studies, for example, utilize the amount of CO_2 emissions as a proxy for environmental degradation to examine the underlying impact of higher financial risks on the greenhouse effect; nevertheless, their conclusions are conflicting (Le et al., 2020; Zhang & Chiu, 2020). The significant finding of our research is that higher financial risks harm global green growth; precisely, a 1% rise in financial risks reduces global green growth by 0.008%. To put it another way, the continual increase in financial risks could impede global green growth (Zhao, Dong, et al., 2022).

The need to find the best technique and resources to solve ecological problems without sacrificing economic growth is pressing in light of their increase. A shift from a resource-based to a renewable energy-based model of economic growth is necessary. Two goals are possible means of doing this: Achieving macroeconomic stability is critical for economic growth, and green development requires minimizing environmental damage and increasing resource use efficiency (Y. Chen et al., 2023).

The study concludes that natural resources harm China's economic development, indicating the existence of the resource expletive hypothesis in China. In addition, technological advancements, an increase in the financial risk index, and craft contribute to China's economic expansion. We also discover that investment and technological innovation improvement can significantly impact a nation's economic performance. Finally, we observe a negative correlation amid financial risk and China's economic performance (Xu & Zhao, 2023). The results show that environment-related technologies contribute to green growth in BRICS nations, confirming the high optimism of long-term forecasts of environmental inventions and patents. Green growth in the BRICS nations is predicted to expand as financial globalization is expected to develop (R. Chen et al., 2023).

H3: Green growth can significantly impact greenhouse gas emissions and climate change.

H4: Green growth can have a significant impact on financial risk.

2.3.2 Renewable Energy Consumptions

A rise in global temperature and a slew of unfavourable environmental conditions are directly attributable to the growing rate of industrialization throughout the world and the overexploitation of non-renewable energy sources (Mohsin et al., 2021). Before the Industrial Revolution, about 1850, the average atmospheric concentration of carbon dioxide (CO_2) rose from 285 to 419 parts per million (Ali et al., 2021). Thus, the United Kingdom Meteorological Office predicts that the average worldwide surface temperature would rise by between 0.97 and 1.21 °C between 1850 and 2022, with a core estimate of 1.09 °C, and that 2022 will be one of the hottest years on record (Sangomla, 2022). In addition, worldwide emissions of greenhouse gases are anticipated to increase by 50 percent by 2050, primarily due to CO_2 emissions from non-renewable energy sources (Spirito et al., 2014). The average atmospheric CO_2 concentration, as well as surface and ocean temperatures throughout the world, will continue to rise unless effective policies and technologies are implemented to cut or manage CO_2 emissions. Significant damage to the human living environment has already been caused by the rising global temperature due to these greenhouse gases. This includes the possible extinction of some species, the loss of biodiversity, droughts, floods, forest fires, acidification of the oceans, the melting of the south and north pole glaciers (NSPG), and sea-level rise (Jahangir et al., 2022).

The availability of finance at acceptable interest rates is one of the key benefits of a stable financial system, which makes investments in renewable energy projects that would otherwise be out of reach (Ahmad, Ahmed, Yang, et al., 2022). Initial costs for renewable energy initiatives are excessively high, necessitating bank and other financial support. Similarly, a stable and efficient financial system reduces the effects of pollution by providing subsidized loans to businesses and industries that adhere to environmental regulations. This practice separates economic growth and CO_2 emissions, facilitating renewable energy projects' deployment (A. Baloch et al., 2022; Bo et al., 2022; Juyal et al., 2010).

H5: Renewable energy has a significant impact on greenhouse gas emissions.

H6: Renewable energy has a significant impact on financial risk.

2.3.3 Technological Innovation

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 to make the idea commercially successful (Garcia & Calantone, 2002). Past studies explore the effect of technological advancement on economic growth. According to a study, the quantity and quality of innovative activity are related to economic growth (Hasan & Tucci, 2010). Another study demonstrates that energy availability is essential for growth and that energy consumption and output are highly correlated. Because of rising energy availability, improved technology, and superior fuels, economic productivity and growth are no longer stifled by insufficient energy supplies. Energy is still vital, in any case. In developed and some developing nations, the amount of energy utilized per unit of economic output has decreased due to technological advancements and a switch from coal to higher-quality fuels, particularly electricity (Simmons, 2011).

According to research by (Kihombo et al., 2021), which examined innovation's effect on ECFP in Western Asia and Central Asia, ECFP fell as technological innovation grew. Technical advances are crucial for lowering the extent of ECFP, according to research by (B. Yang & Usman, 2021) that analyzed the economies from 1990 to 2016; the countries included in this analysis are Brazil, India, China, and South Africa. 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 more considerable influence from innovation (Khattak et al., 2022; Kihombo et al., 2021; Liguo et al., 2022). All looked at the impact of innovations on reducing emissions in distinct locations. It has also been 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). However, more research is needed to understand how technological development affects the ecological footprint of economically sophisticated nations.

H7: Technological innovation can have a significant impact on greenhouse gas emissions.

H8: Technological innovation can have a significant impact on financial risk.

2.3.4 Financial inclusion

Access to basic banking services in the formal economy is a key component of financial inclusion, especially for those living in poverty (Allen, 2016). Policymakers and researchers have paid close attention to financial inclusion for four main reasons. To realize the United Nations' sustainable development objectives, financial inclusion is essential (Demirgüç-Kunt & Singer, 2017); financial inclusion helps enhance social inclusion in many societies (Coad & Reid, 2012). As a third benefit, financial inclusion assist in reducing poverty levels to an acceptable level (Chibba, 2009) and. Fourthly, To combat the issue of financial exclusion

(Andrianaivo & Kpodar, 2011), Policymakers in several nations continue to commit substantial resources to boost the amount of financial inclusion in their respective nations.

There have been a plethora of research on several dimensions of financial inclusion, including its role in fostering development (Claessens et al., 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 (Kabakova & Plaksenkov, 2018). Increasing the poor's access to financial services is widely recognized as a viable strategy for combating budgets for studies (Beck et al., 2007). (Demirgüç-Kunt & Singer, 2017) note, however, that most evidence on the connection between financial inclusion and growth resides at the individual and micro levels. The link underlying financial inclusion and broad economic growth remains poorly documented. At least in theory, it is possible to show a connection between financial inclusion, macroeconomic development, and inequality. However, the world bank points out that this correlation is not black and white. According to the literature, entrepreneurial endeavor is a function of capacity and not parental wealth (Beck et al., 2009). This means that in a perfect world, economic agents with the most potential for entrepreneurship would always have access to finance to fund their projects.

Since the Maya Manifesto and the G-20 Financial Inclusion Plan (Demirgüç-Kunt & Klapper, 2012). Financial inclusion has garnered a lot of focus in recent times. Policymakers and academics have emphasized financial inclusion for numerous reasons (Ozili, 2021). proposes four significant causes, first, as a strategy for the United Nations' (UN) sustainable development objectives (Berger et al., 2017); second, in connection with social inclusion (Bold et al., 2012); third, to decrease the level of poverty (Beck et al., 2007); and lastly, concerning socioeconomic benefits (Sarma & Pais, 2011). Theoretically, academicians concur that financial inclusion significantly promotes economic growth (McKinnon, 1973). There is no question that financial inclusion 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 efficiently. The financial sector also significantly decreases energy emissions by promoting improvements in energy production technology to reduce pollution (Jensen, 1996). While studies have focused on the monetary benefits of financial inclusion, less attention has been paid to how it relates to greenhouse gas emissions.

Financial inclusion could affect CO_2 emissions both positively and negatively. Investments in renewable technologies are made more practical because of the increased access to important and cost-effective financial schemes made possible by financial inclusion for firms and individuals. Therefore, improved environmental measures that limit human impacts to climate change are more widely available, affordable, and adopted in regions where inclusive finance institutions are in place (IPA 2017). As a result of limited access to cash and credit, many farmers in low-income areas are unable to invest in renewable energy technologies like solar energy microgrids, which are more affordable and produce fewer greenhouse gas emissions than coal power plants (IPA 2017).

These are typical instances in which the availability of reasonably priced financial services and products fosters the use of renewable energies and the implementation of environmental protection services, which decrease CO_2 emissions by reducing fossil fuel consumption (Le et al., 2020) analyzed the effects of foreign direct investment, urban sprawl, energy consumption, and Industrialization in 31 different nations. The study looked at data from 2004 to 2014 and found an upward trend in financial inclusion and carbon dioxide emissions. Financial inclusion's effect on greenhouse gas emissions was evaluated (Renzhi & Baek, 2020), for 103 countries. The research showed that financial inclusion lowers CO_2 emissions using the GMM technique and data collected annually between 2004 and 2014. Financial inclusion could help lessen the negative consequences of economic development through raising public awareness of environmental issues (Zafar et al., 2021).

Therefore, financial inclusion mitigates ecological degradation. Environmental quality can be improved by investing in renewable energy sources; thus, it also initiates research and development, grow economic operations, and lures FDI (Frankel & Romer, 1999a). Lower finance costs, streamlined procurement procedures, and less oil pollution are all results of a well-developed financial sector (Kirikkaleli & Adebayo, 2021). However, to prevent rent-seeking and the accompanying environmental degradation, a coordinated development policy framework should be developed to increase the accountability and openness of local governments, especially those that are highly reliant on natural resources. In order to improve environmental quality and support development that is both low-carbon and energy-efficient Sustainable Development Goals (SDGs), economic actors should be given access to green growth-oriented financial services (Ahmad & Satrovic, 2023).

There is a lack of consistency in the empirical data linking financial inclusion with environmental deterioration. This research investigates how monetary inclusion affects GHG output. We specifically investigate the hypothesis that if all people, even the most marginalized, have access to sufficient financial services, GHG emissions in the region will decrease.

H9: Financial inclusion can have a significant impact on greenhouse gas emissions.

H10: Financial inclusion can have a significant impact on financial risk.

2.3.5 Soft Infrastructure

With the advancement of science and technology today, broadband infrastructure is recognized as a critical element for enhancing industrial competitiveness. Countries worldwide are proactively seizing the opportunity presented by implementation of plans and policies to expand the availability of their lightning-fast broadband networks are the foundation of the "information superhighway" of the future. This development of the internet and information and communication technology (ICT) significantly impacts the scale and structure of energy consumption, posing challenges to energy sustainability (A. Lee et al., 2021; Wu et al., 2021).

Investigating the relationship between Broadband Internet access and energy conservation is essential. High-speed broadband plays a crucial role in the infrastructure of information and communication technology (ICT) and is considered a strategic asset for fostering the growth of the digital economy (DeStefano et al., 2018; Lee et al., 2022). Its significance extends to influencing social and economic activities and power infrastructures, which impact the sustainability of energy and the environment. Energy efficiency is crucial, considering various input factors and overall output in economic production. It is referred to as total-factor energy efficiency (TFEE). The current energy structure, primarily reliant on fossil fuels, is associated with high pollutant emissions. While transitioning to cleaner energy sources can reduce emissions, it may also lead to increased energy consumption and a decline in TFEE. China has advanced coal energy technologies with high utilization efficiency, whereas renewable energy technologies are less mature and comparatively less efficient. This poses a challenge as reducing emissions and improving TFEE can conflict. Scholars have proposed total factor energy efficiency, a green notion (GTFEE), which incorporates pollutant emissions into evaluating energy efficiency. The development of information and communication technology (ICT), including broadband infrastructure, has implications for energy consumption, energy sector productivity, and the energy structure (Appiah - Otoo & Song, 2021; Wu et al., 2021). The GTFEE indication can be updated to reflect these modifications. Accordingly, the effects of ICT growth and broadband infrastructure on GTFEE are the focus of this research. The expansion of the digital economy is directly tied to the development of broadband infrastructure, an integral part of information and communication technology (Bo et al., 2022; DeStefano et al., 2018).

It encourages the use of digital technologies, reduces the price of transactions, and speeds up the dissemination of data. Massive volumes of high-frequency data are transmitted to facilitate smart energy management, which is greatly facilitated by a robust broadband network. Broadband infrastructure and information and communication technology also aid in the conscious revamping of power infrastructure, reduce the risks associated with renewable energy, and speed up the shift to a more sustainable energy system. There is a great deal of risk and uncertainty associated with the energy transition process, from price swings in energy to questions about how well it can improve efficiency (Y. Zhang et al., 2022), which can have ripple effects on economic and monetary structures. Digital infrastructure, however, can lessen the blow of such unknowns (Lee et al., 2022a, 2022b).

Additionally, expanding the ICT sector, driven by broadband infrastructure, increases energy consumption by enabling economic activity. Consequently, there are advantages and disadvantages to implementing a broadband infrastructure to achieve energy sustainability. Adopting digital infrastructure, particularly broadband networks, can foster regional innovation in green technologies, improving energy conservation, reducing pollution emissions, and environmental sustainability (Ma et al., 2021). Integrating technology for sharing information and making connections; the shift to digital may help the environment and advance green, sustainable energy (Wu et al., 2021b). The As the fourth wave of industrialization, digitalization is a game-changer, with far-reaching economic and social consequences as a result of manufacturing innovation, distribution, circulation, and consumption. Several research have found that the connection between digitization and energy sustainability is complex and ambiguous (C.-C. Lee et al., 2022; Y. Sun et al., 2022; Q. -J. Wang et al., 2022; Wu et al., 2021).

Broadband infrastructure, as a component digital economic and social revolution, which improves the speed and accuracy of information sharing while lowering transaction prices. Analyzing the role of broadband infrastructure can provide insights into how the mechanisms of digital transformation influence sustainable development, particularly in information transmission, leading to lower transaction and data expenses., By studying the impact of broadband infrastructure on financial stability, we can better understand connection between digital transformation, environmental and financial sustainability, shedding light on the intricate dynamics at play in the digital era.

H11: Soft infrastructure can have a significant impact on greenhouse gas emissions.

H12: Soft infrastructure may possess a significant impact on Financial Risk.

2.4 Control Variables

This study provides a literature evaluation on the moderators of the association between the independent and dependent variables. This analysis surveys the literature on the connection between control factors including urbanization, industrialization, population growth, and literacy levels and outcomes like sustainable development and financial risk.

2.4.1 Industrialization

In the EKC hypothesis, Industrialization is typically viewed as the factor that growths pollution (K. Li & Lin, 2015; Lin et al., 2015; Özbuğday & Erbas, 2015). This influence of composition, which might have a beneficial or detrimental impact on GHG emissions, is responsible for the variations in industry share. (Tian et al., 2014) found that fundamental shifts in the economy comprising a transition from farming, mining, and light industry to resource-related industrial production resulted in a sharp increase in greenhouse gas emissions. In contrast, (Naudé, 2011) proposed that Industrialization could reduce environmental issues by easing the transition of ownership, labor from agriculture to industry, thereby reducing greenhouse gas pollution from forest clearance and environmentally destructive farming (Kaika & Zervas, 2013).

Alternately, (Anser et al., 2020) investigate why most businesses have high energy consumption and emissions. Using the DDF model to analyze data from 21 countries, they discovered that the inclusion or exclusion of undesirable output has a significant influence on efficiency levels (De Giovanni & Cariola, 2021) discovered that accelerated Industrialization creates an inefficient environment, which has resulted in a variety of environmental problems, such as exhaustion of energy resources, emissions, and environmental deterioration (Anser et al., 2020; Tirkolaee et al., 2020).

They proposed the factor endowment hypothesis. By the study, heavy energy companies produce significantly more pollution than other sectors, suggesting that a revenue increase in those industries will result in considerably more pollution than in other sectors. (Z. Chen et al., 2022) believe that actively pursuing industrial reorganization and advanced technology to report the issue of the natural world while growing the economy is a prudent strategy, but that environmental protection is essential.

2.4.2 Urbanization

Individuals migrating from rural to urban areas is known as urbanization. Due to the expansion of the economy, urbanization has increased. Numerous studies have demonstrated that an increase in urban population causes more greenhouse gas emissions (Li & Lin, 2015; Y. Zhao et al., 2016). Thus, the scale effect exists when urbanization leads to rapid expansion in metropolitan areas' demand for energy and their production of greenhouse gases, as well as rapid growth in private transportation, massive development of public infrastructure (such as road networks, sanitation, and drainage systems), and intensification of urban economic activities. There are environmental benefits and drawbacks associated with urbanization by composition. When people leave rural areas to work in urban factories, the environmental effects are adverse.

The urban population harms greenhouse gas emissions. We discovered a causal relationship between urbanization and GHG emission in 84% of nations across all seven regions. In contrast, only 16% of countries have positive outcomes, whereas low-income nations see no correlation at all. The effect of the URB mechanism on EVP is an important topic that numerous researchers are still investigating (Zhou et al., 2021). According to this viewpoint, economic development and progress, combined with the effects of URB, have been Due to higher energy consumption and CO_2 emissions, the... recognized primary cause of environmental degradation. (Fan et al., 2019) URB and EGC affect nations' EVP and social progress through a transitional phase. Their results also revealed the complex relationship between URBs and environmental quality. While socioeconomic conditions in a country improve, economic development and urban sprawl may have adverse environmental effects. (Musah et al., 2021) investigated the relationships between URB-EVP in West African countries. Their findings indicate that URB has a direct and positive effect on EVP.

2.4.3 Literacy level

Raising people's levels of education increases their human capital, which increases labor productivity, which in turn increases economic output. Consequently, advancements in the field of education have been found to have a beneficial effect on national GDP (Paraggua et al., 2022). Understanding studying how people learn about money, save, and spend is essential in light of the significance of the challenges governments face in achieving Sustainability on all fronts (environmental, economic, social) (López-Medina et al., 2022). Government policies for financial knowledge in and out of the classroom should be updated to emphasize financial literacy as a means to individual prosperity (López-Medina et al., 2022). This will positively impact national economic growth and long-term economic development. The implicit premise underlying there is a direct causal relationship between financial education and political success. As more (formal) financial education activities are implemented, consumers' financial literacy level will increase, enabling them to make more appropriate and responsible financial decisions (Șimandan et al., 2022). Globally, financial literacy has been acknowledged as a crucial component of economic and financial growth. The idea of financial literacy has evolved as a result of the development of new financial tools, the growing importance of financial inclusion, and the link between the two is undergoing a radical transformation and becoming more inclusive, with an increased emphasis on sustainability, sustainable consumption, and environmental protection (Todorov et al., 2023).

2.4.4 Population Growth

Population expansion increases resource consumption, refuse generation, and environmental degradation. These problems are worsened by consumer habits, technological development, social structure, and patterns of resource management (Zahoor et al., 2022; Zakari et al., 2022).

The population and economic operations of nations influence their natural resources. A nation with bountiful natural resources can develop more quickly. Natural resources are positively correlated with economic growth. Financial resources contribute to the economic development of a nation by creating employment opportunities, reducing destitution, and enhancing its infrastructure. Natural resources can finance mining, energy, timberland, stone quarries, and other long-term company assets. Natural resources are vulnerable to exhaustion(Arslan & Arslan, 2022; Nichols et al., 2022).

2.5 Theoretical Background

Environmental Kuznets curve (EKC)

Using the three proxies, SO2, suspended particles, and dark matter, we explored the EKC theory. Later, the EKC was put to the test in the literature using various pollution indicators. The degree of pollution may be divided into two main groups. Most of the literature has focused on the first group, which includes global air pollution like CO_2 emissions. However, local gases including urban air concentration, SO2 emissions, NOx emissions, CO_2 emissions, suspended particulate matter, etc. have also received attention in the literature. Additionally, there has been a lot of literature on water contamination, including the presence of pathogens and heavy metals in the water. However, in order to verify the EKC hypothesis, the research focuses on the connection between the macroeconomic performance of the countries and pollution emissions(Grossman, & Krueger, 1991).

During the initial phase of the EKC, economies may transition from fundamental economic activities to industrialization. This idea is consistent with the concept of flourishing first and then tidying up (Zada, & Gatto, 2023). Thus, economies prioritize economic growth and employment over environmental concerns (Dasgupta et al., 2002). In the pursuit of economic development, developing economies relax their trade and environmental policies, which increases the size of the economy, modifies its composition, and impacts production techniques. Thus, vast amounts of natural resources and energy are used to sustain economic growth, which pollutes the environment (Grossman, & Krueger, 1991). Then, communities care for the environment in order to attain a higher standard of living (Selden & Song, 1994) and governments create environmental regulations to serve the communities in order to maintain a pure environment. Thus, this phase may encourage the development of sustainable technologies and energy sources to reduce pollution levels. In addition, a structural shift may occur, and polluting industries may replace service industries or healthier manufacturing industries (B Bolin et al., 1995). Furthermore, economic growth may support research and development (R&D) activities, which would result in the replacement of polluting technologies with greener ones (Komen et al., 1997). Consequently, technique and composition effects may emerge at this juncture to produce aesthetically pleasing environmental effects of economic growth.

The foundation of this study is rooted in the Environmental Kuznets Curve (EKC) theory. The EKC theory suggests that as economies develop, there is an initial increase in environmental degradation, but as they reach a certain level of development, environmental quality starts improving. In this study, we aim to explore the relationship between green growth, financial stability, and other economic factors with the objective of enhancing environmental quality.

Our research goes beyond the conventional focus on economic growth and recognizes the importance of incorporating sustainability measures into economic development. We believe that pursuing green growth, which emphasizes environmentally friendly practices and technologies, can lead to improved environmental outcomes. By examining the interplay between green growth and financial stability, we aim to understand how these factors can positively influence environmental quality. Moreover, our study takes a comprehensive approach by considering various economic factors that may impact the environment. This includes factors such as resource efficiency, renewable energy adoption, pollution control measures, and sustainable production and consumption patterns. By analysing these factors in conjunction with green growth and financial stability, we seek to identify effective strategies for enhancing environmental quality

CHAPTER 3

RESEARCH METHODOLOGY

This study will examine the role of economic indicators in promoting the SDGs and financial risk. This study takes green growth, financial inclusion, soft infrastructure, Alternative energy sources and cutting-edge technology such independent variables, and the Dependent variables are sustainable development and financial risk. This study takes population growth, urbanization, literacy level, and industrialization as a controlled variable. Research

3.1 Philosophy

When discussing the social sciences, two primary research philosophies or perspectives prevail positivism and social constructivism/interpretivism. Positivism adopts an objective and external stance, emphasizing the observation of phenomena from a researcher's viewpoint. It is rooted in quantitative methodologies and follows a question-driven, objective-based approach in natural science models. Positivism encompasses reasoning, validity, the pursuit of truth, sensory experiences, and intuition. Proponents of positivism argue that the social world should be studied scientifically, like the natural sciences. Sociologists advocate for the scientific investigation of societal issues to foster societal development (Jamieson, 1987). From a positivist standpoint, research commences with a hypothesis, and data collection should be conducted objectively, employing categorical frameworks.

The alternative perspective, interpretivism or constructivism, stands in contrast to positivism and is often called anti-positivism. It recognizes a fundamental distinction between the social world and the natural world. Advocates of interpretivism argue against treating or studying societal issues in a strictly scientific manner, as individuals exhibit unique attitudes, behaviors, and personalities. Human behavior is seen as an unpredictable aspect of human life, leading to the rejection of scientific generalizations. Interpretivism focuses on subjective interpretations and emphasizes validity (Jamieson, 1987). Qualitative methods are commonly employed in the interpretive paradigm. Similarly, according to (Melia, 2010) and (Hatch & Cunliffe, 2006), individuals analyze issues based on their expectations, experiences, and memories.

This study incorporates the Positivism philosophy, which emphasizes scientific observation of phenomena. It employs quantitative methods and an objective approach to comprehension. In this analysis, we look at how global warming through the lens of sensations and intuition to arrive at the truth. Proponents contend that the primary cause of global warming should be investigated scientifically. In addition, this study encourages the investigation of societal issues to advance social progress.

3.2 Research Approach

The following phase, after settling on a theory of investigation, is identifying the research approach. Saunders et al. (2009) state that there exists. Two main approaches to doing research are inductive and deductive. The inductive approach, the bottom-up approach, involves progressing from specific observations to general conclusions. In this approach, researchers gather information to develop a theory, making it a theory-building approach (Saunders et al., 2009). Simply in the event of the deductive approach, the research applies the way of going from specific to general. The deductive approach is also called the top-bottom approach. In the deductive approach, the researcher develops a hypothesis or theory and tests that hypothesis or theory with the process of proper research strategy (Shah et al., 2015). It means the deductive approach is a theory-testing rather than a building. The deductive approach has several characteristics mentioned by(Saunders et al., 2009) for identifying a valid research approach.

- There is a correlation between the variables, suggesting a cause-and-effect.
- The researcher is independent in observations.
- Concepts are operationalized in a way to analyze the facts quantitatively, and
- The results can be generalized.

Using a deductive methodology, this study presents hypotheses addressing the relationship between greenhouse gas emissions and various economic indicators. To assess these hypotheses, the study employs a deductive method in which specific conclusions are derived from general principles or theories. The study then generalizes the findings from the data analysis, providing broader implications and insights regarding the relationship between greenhouse gas emissions and economic indicators.

3.3 Research Design

According to the positivistic perspective on research, it is essential to conduct social science and business research in a scientific manner. This entails following a proper research design to achieve the aims and objectives of the study. (Sekaran, 2003) has identified four main research types, exploratory, descriptive, causal, and correlational research, which serve distinct purposes within the research process.

Exploratory research is employed when there is insufficient existing knowledge, information, or solutions regarding a particular issue. This study plan is great for doing in-depth, primary data collection via interviews and direct observation. Exploratory research is often conducted using qualitative approaches. (Saunders et al., 2009) describe exploratory research as

We need a versatile approach that can be customized to suit different situations. Specific needs. Situation. (Hair et al., 2006) state that there is no predetermined course of action for finding a solution to the problem in exploratory research.

Descriptive research, referred to as "Ex post facto research" by Kothari (1990), involves a research design where the researcher does not have control over the variables. (Ghauri et al., 2005) suggest to describe a study is employed to find solutions for structured problems and determine where to search for those solutions. (Hair et al., 2006) and (M. J. Baloch et al., 2013) highlight that descriptive research addresses questions about what, when, where, who, and why. In light of (Sekaran, 2003), the descriptive research design is handy for portraying the features or characteristics of variables within an existing problem. For instance, if a university's management is interested in studying variables such as student age, gender ratio, courses studied, and the number of senior and junior students, adopting a descriptive research design would clarify these aspects.

This study employs causal and correlational research designs to explore and investigate the relationship between variables. By employing these two methods, the researchers intend to examine the cause-and-effect relationships between the investigated variables and any possible associations or correlations between them. The ultimate purpose of this study is to increase our understanding of the existence and nature of these variables.

3.4 Nature of the Research Study

In conducting research, a researcher must be specific in selecting a research type, as this choice can significantly impact the results and the level of significance of the research model (Antony et al., 2005; Scuffham et al., 2000). Sekaran (2003) identifies two main types of research: quantitative and qualitative.

In contrast to Sekaran's classification, Creswell (2009) presents a broader categorization of research types, which includes quantitative, qualitative, and mixed methods. Creswell explains that there are less rigorous (quasi) experiments and correlational analyses within quantitative strategies. He further identifies two sub-methods within quantitative strategies, namely surveys and experiments. Surveys involve gathering data on a specific issue from a sample population using questionnaires and structured interviews.

On the other hand, experimental research aims to determine the impact of a specific variable on another variable. Experimental research focuses on quantifiable outcomes expressed in digits, numbers, and mathematical ratios. According to Creswell (2009), the qualitative research strategy encompasses several approaches, including Research strategies such as narratology, phenomenology, ethnography, and grounded theory, and case studies. Ethnography is a research method employed when the researcher aims to investigate a cultural group over an extended period. Primary data is collected through participant observation and extensive interviews (Creswell & Zhang, 2009). Creswell further explains that grounded theory research involves moving beyond descriptive studies to generate a theory. The term "grounded" implies that the theory is not preconceived but emerges from the data. In narrative research within qualitative studies, the researcher explores the events and stories of the participants, arranging and narrating them chronologically. Creswell (2007) explains that narrative studies encompass various forms, such as autobiographies, biographies, life history accounts, and oral histories, focusing on the life experiences of the research subjects.

Additionally, the qualitative strategy can also be applied through case study analysis. According to Sekaran (2003), a case study involves conducting an in-depth and comprehensive investigation of a specific issue across different organizations. Sekaran (2003) further suggests that the case study strategy is employed to solve problems and develop theories that can be evaluated through empirical research. When using the case study approach in research, it is essential for the researcher, as stated by Creswell (2007), to identify and define what will be studied concerning the participant or subject under investigation.

This study primarily employs quantitative research methods to identify and evaluate the research problem and investigate and analyze the outcomes. Using quantitative research methods, the researchers utilize numerical data, statistical analysis, and objective measures to systematically collect data, evaluate the issue, and draw conclusions based on empirical evidence. The purpose of employing quantitative research methods in this study is to provide a rigorous and systematic examination of the problem and to generate trustworthy findings that add to the body of knowledge already accumulated in the field.

3.5 Population and Sample

The term "population" refers to the entire group of individuals or objects used to derive conclusions. Researchers frequently attempt to generalize a particular group of individuals or objects, known as the "target population " (Rahman et al., 2022).

The term "sample" is used to describe a subset of a population from which generalizations can be made. Therefore, a large enough sample is required for reliable conclusions to be drawn. That is, it's the smallest feasible sample size that would still provide a reliable estimate of the determined proportion of the population, accounting for sampling variability and other factors. Therefore, selecting a sufficient sample is a perennial challenge in statistics. The margin of error, critical value of the normal distribution, percentage of the sample, and population size may all be used to calculate its equation.

$$\text{Sample Size } n = N * [Z2 * p * (1-p) /e2] / [N - 1 + (Z2 * p * (1-p) /e2]..... \quad (1)$$

The sample size calculated from the population of 210 countries is 84 at the minimum range, but the research took 111 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 111 nations is selected due to the access to reliable and complete data. The World development indictors, 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 essential variables under consideration, the analysis 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.

As climate change is a global issue in that context, this study considers the overall world as a population. While all nations are included in the study's scope, a sample of 111 nations was chosen because they had access to trustworthy and complete data. The World Bank, OECD, and Our World Data Bank are only a few of the respected and reliable data sources used in this study. Since this time offers the most consistent and comprehensive data for the critical variables under consideration, the analysis time 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 population trends and patterns.

3.6 Data and Variables

This research examines the relation and role of financial risk, technology innovation, green growth, soft infrastructure, renewable energy, and financial inclusion on sustainable development and the effect of sustainable development technology innovation, green growth, soft infrastructure, renewable energy, and financial inclusion on greenhouses gases emission. It considers country-level data ranging from 2004-2019. This study will be done under quantitative techniques by using secondary data. Researchers are following the study of (Q. Wang & Dong, 2022).

3.6.1 Entropy Weighted Method

Step 1-Assigning an entropy weight to each parameter.

In order to calculate the entropy value, we need to know how many samples of there are I = 1, 2, 3,, z). Parameters j are scored on a scale from 1 to t for each sample. Therefore, the Eigen value matrix X may be built using Eq. 1:

Step 1

$$X = \left\{ \begin{matrix} X_{11} & X_{12} & \dots & X_{1t} \\ X_{21} & X_{22} & \dots & X_{2t} \\ . & . & \dots & . \\ . & . & \dots & . \\ . & . & \dots & . \\ X_{z1} & X_{z2} & \dots & X_{zt} \end{matrix} \right\}$$

Efficiency, cost, fixed, and interval feature indices are all possible classifications. Eq. 2 provides the normalizing building function (Y ij) for efficiency types:

Step2

$$Y_{ij} = \frac{x_{ij} - (x_{ij})_{\min}}{(x_{ij})_{\max} - (x_{ij})_{\min}}$$

Y ij is the normalization construction function for a parameter (j) in a specif sample (i). (X ij) min and (X ij) max represent each index's minimal and maximum values in the initial quality analysis data. To eradicate the error caused by distinct dimensions and units, the initial matrix must be transformed prior to calculating the weights. As shown in Eq. 3, the standard grade matrix Y can be acquired after transformation.

Step 3

$$Y = \left\{ \begin{matrix} Y_{11} & Y_{12} & \dots & Y_{1t} \\ Y_{21} & Y_{22} & \dots & Y_{2t} \\ . & . & \dots & . \\ . & . & \dots & . \\ . & . & \dots & . \\ Y_{z1} & Y_{z2} & \dots & Y_{zt} \end{matrix} \right\}$$

The process of standardizing measurements (Docheshmeh Gorgij et al., 2017; Q. Huang & Wei, 2012). The ith index's standard deviation in the jth sample is denoted by pij, and its calculation is as follows:

Step 4

$$P_{ij} = y_{ij} / \sum_{i=1}^{z} y_{ij}$$

In the EWM, the entropy value Ei of the ith index is defined as

Step 5

$$E_j = \left(\frac{1}{\ln Z}\right) \times \sum_{i=1}^{z} \ln P_{ij} \times P_{ij}$$

In the EWM evaluation, PIJ. lnPij=0 is typically set when pij = 0 for calculation convenience. The range of entropy value Ei is between 0 and 1. The greater the Ei, the greater the degree of differentiation of index I and the more data can be extracted. The index should therefore be accorded a greater weight. Therefore, the technique for calculating weight wi in the EWM is (Amiri et al., 2014; Liu et al., 2010).

Step 6

$$W_j = (1 - E_j) / \sum_{j=1}^{t} (1 - E_j)$$

Another study conducted by (Cao et al., 2022) cast-off entropy-weighted technique to calculate the green growth index, and its data was collected from the OECD and World Bank. Coming to the independent variable green growth is measured by CO_2 emissions, energy consumption, GDP, Industrial waste gasses emission, Mean annual exposure to PM2.5 air pollution, environment related R&D budget, and nitrogen emissions due to the high range of data availability. Following the literature, the researcher identified the renewable energy consumption of total energy, and its data is collected from WBI. For financial inclusion, this study uses the ATM per lac and branches per lac as an indicator and data collected from WBI.

For the technology innovation, the researcher uses the proxy of measurement as medium technology export % of total manufactured exports, and for the soft infrastructure, the indicator is fixed broadband subscriptions. The data is downloaded from world development indicators. Industrialization, urbanization, population growth, life expectancy, and data are downloaded from the website of worldwide indicators.

3.5.1 Data Sources and Period

This study utilizes diverse data sources, including World development indicators, OECD data, and Our World Data Bank. These sources have been selected as the primary data providers for the study. The time for this research spans 16 years, specifically from 2004 to 2019. This duration was chosen based on data availability for the main variables under investigation. By incorporating data from multiple reputable sources over this extensive time, the study aims to provide a comprehensive and robust analysis of the research topic.

3.6 Variables Description

Model 1

3.6.1 Dependent Variables

The Dependent variables are sustainable development while sustainable development is measured by different indicators, i.e., CO_2 emission, greenhouse gas emission, ecological footprint, carbon footprint, etc., in different contexts (Afzal et al., 2022; Awosusi, Adebayo, Kirikkaleli, Altuntaş et al., 2022; Istraživanja & 2022, C. Li et al., 2022.; D. Zhang, Mohsin, Rasheed, et al., 2022). This study will measure sustainable development with all greenhouse gases emission (Afzal et al., 2022).

3.6.2 Independent Variables

This research examines the relation and role of independent variables of financial risk, technology innovation, green growth, soft infrastructure, renewable energy, and financial inclusion on sustainable development use of greenhouses gases. It considers country-level data ranging from 2004-2019.

3.6.3 Control Variables.

This study's-controlled variables are industrialization, population growth, urbanization, and Literacy level. This study measures population growth with the percentage of annual growth, urbanization with the percentage of the urban population (Q. Wang & Dong, 2022), Industrialization with industrial-added values, and literacy level with secondary education enrolment per one lac children.

Model 2

3.6.4 Dependent Variables

The Dependent variable as a financial risk. This study measured the financial risk by indicators of total debt service (% of export of goods, service and primary income) (Y. S. Wang, 2022).

3.6.5 Independent Variables

Sustainable development is measured by different indicators, i.e., CO_2 emission, greenhouse gas emission, ecological footprint, carbon footprint, etc., 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 measured sustainable development with all greenhouse gases emission following the study of (Afzal et al., 2022). The other variable for this study is green growth; calculating entropy-weighted method indicators used in the calculation are as follows. 1. Resource consumption (Total water consumption, Energy consumption Standard coal, Urban Construction Land Km2) 2. Environmental pollution (Wastewater discharge Tons, Solid waste emissions Tons, Industrial waste gas emissions, Nitrogen emissions) 3. Economic output (GDP, R&D Environmentally related government R&D budget, % total government R&D). This study used these seven indicators to calculate the green growth index. This study measures financial inclusion with accessibility, availability, use of banking services, technological Innovation with Medium technology export %of total manufactured export, renewable energy consumption with percentage of total energy, and soft infrastructure fixed broadband subscriptions as these measures are used earlier (Saleem et al., 2022).

3.6.6 Control Variables

This study's-controlled variables are industrialization, population growth, urbanization, and literacy level. This study measures population growth with the percentage of annual growth, urbanization with the percentage of the urban population (Q. Wang & Dong, 2022), industrialization with industrial-added values, and literacy level with secondary education enrolment per one lac child.

3.7 Variable Definition

This study aims to learn more about how sustainable development is related to several independent variables, including financial risk, green growth, renewable energy, soft infrastructure, technological innovation, and financial inclusion. The study's appendix 1 contains these variables' precise definitions and explanations. The provision of these definitions in the appendix enhances the lucidity and readability of the research by providing readers with a precise comprehension of how these variables are defined and measured in the study.

3.8 Methodology

The approach used for this investigation included the utilization of secondary panel data. The researchers obtained essential data from pre-existing sources, such as databases. The goals and research questions of the study were effectively built upon the foundation of these secondary data sources. The acquired information was carefully chosen and filtered according to its applicability and relevance to the study's objectives. After gathering the data, the researchers conducted a battery of exacting tests to ensure it was accurate and dependable. They employed the proper statistical methods and analytical equipment. In this study, secondary panel data provides a broader and more thorough coverage of the study's issue, allowing for a more profound knowledge of the studied phenomena. This study uses Stata#17 software for statistical analysis.

3.8.1 Panel Data

Each cross-sectional member of a panel data set has its own time series. The i and t subscripts, which we previously used for time series and cross-sectional data, respectively, are used to indicate panel data. This is because time series and cross-sectional dimensions are present in panel data (Asteriou & Hall, 2015).

3.8.2 Descriptive Statistic

We may employ a variety of measurements to better understand how a variable behaves. The average, or mean, is represented by the symbol x, and provides the variable's standard deviation. The variance, represented by the symbol 2x, informs us how much the variable's values depart from the mean. We may calculate the standard deviation (x), which is the square root of the variance, to get an idea of how widely distributed the variable is.

The difficulties that come up while dealing with data that has many dimensions are commonly known as the "curse of dimensionality." The inaccuracy in estimating or approximating those variables rises as the number of variables grows. The pace at which the inaccuracy is reduced slows down as the complexity of the data rises. In other words, as the number of variables in the dataset increases, it gets harder to correctly assess and generate valid predictions (Prangle, 2015).

3.8.3 Linear Regression

The linear regression model investigates the connections between several factors. The purpose of regression analysis is to establish which of two or more variables has a greater effect over the other. Which variable relies on the other is another way of putting it. That's why there are dependent and independent (explanatory) factors to consider. The goal is to provide an explanation for/a prediction of Y given a range of values for the explanatory variable X. Let's pretend a linear connection exists between X and Y.

3.8.4 Multicollinearity/VIF

It is known as multicollinearity or collinearity when independent variables in a model of regression are significantly correlated. Collinearity can be problematic, considering it enhances the coefficients of regression variability. This means that coefficients can have exaggerated values or signs, change dramatically with minor changes in the data set or independent, and may seem insignificant despite explaining a substantial portion of the total variance. Examining correlations between predictor variables is one method for detecting collinearity, with values above 0.8 or 0.9 indicating collinearity. High values for R-squared when regressing each independent toward all the other predictors are another indicator. The VIF (variance inflation factor) can be calculated to quantify collinearity, with a VIF value of 10 or higher indicating the existence of collinearity (Franke, 2010).

3.8.5 Heteroskedasticity

It refers to the irregular dispersal or dispersion of residuals in an analysis of regression. The Breusch and Pagan (1979) test was utilized to examine the heteroscedasticity of my panel data set. (Rice et al., 2020; Uyanto, 2019). Heteroskedasticity is a statistical phenomenon where the variances in a predicted variable as a function of the independent variable's values or over time, are not constant. This can be visually identified when the residual errors exhibit a widening or narrowing pattern over time. Thus, homoskedasticity signifies "equal spread," while heteroskedasticity indicates "unequal spread." In econometrics, variance is often used as a measure of spread, and therefore, heteroskedasticity refers to the presence of unequal variances (Schwert & Seguin, 1990). Breusch and Pagan (1979) developed the Lagrange multiplier test to detect heteroscedasticity in regression models. Independently, Cook and Weisberg (1983) suggested a broadening of the concept. Breusch and Pagan's null hypothesis is "Data is Homoscedastic," while the alternative hypothesis is "Data is Heteroscedastic (Breusch & Pagan, 1979; COOK & WEISBERG, 1983). The p-value of less than 0.05 is considered statistically significant you will reject the null hypothesis homoscedasticity and instead believe the heteroscedasticity null hypothesis (Breusch & Pagan, 1979).

3.8.6 Cross-sectional dependence

Dependence across samples is a statistical phenomenon in which variables within a dataset demonstrate interdependence or correlation across distinct units or entities. This is prevalent in panel data, in which observations are collected across numerous individuals or cross-sections (Pesaran, 2020).

Put cross-sectional dependence indicates that the values of variables for various panel members are not independent of one another. Within the dataset, there is a correlation or interdependence between the individuals (Munir et al.,2020.; Pesaran, 2021). Preceding generating any panel data models, the importance of cross-sectional dependency cannot be overstated diagnostic tests a researcher should conduct. The existence of this issue determines the next step of action. If the data reveals a cross-sectional reliance, additional analysis steps are required to account for it. Several cross-sectional dependence analyses can be used to detect the issue. These include the (Breusch & Pagan, 1980). LM test, the scaled LM test, the CD test, and the bias-corrected scaled LM test developed by (Baltagi et al., 2012; Pesran, 2004).

For panels with limited cross-sections and temporal dimensions, the CD test performs admirably. Cross-sectional independence, and the null hypothesis in the CD test is "NO cross-sectional dependence exists," while the alternative hypothesis is "Cross-sectional dependence exists. If the significance value is less than 0.05 (If the p-value is less than 0.05, we can accept the alternative hypothesis that cross-sectional associations exist and reject the null dependency in the panel data set (Pesran, 2004).

3.8.7 Stationarity test

Numerous econometric models, including panel data models, significantly rely on the stationarity assumption. Stationarity refers to the stability of a variable or set of variables over time within a panel dataset (Hasan 2019.). It indicates that the statistical features of the variables, such as the mean and variance, do not change systematically within each panel entity over time. In other words, the variability of the variables is not influenced by trends or other time-dependent variables (Khraief et al., 2020; Munir et al., 2020).

The panel data set contains two iterations of analyses to investigate the stationarity of the data. However, the second iteration of panel unit root analyses relaxes this presumption and allows for cross-sectional dependence (Ahmad, Ahmed, Yang, et al., 2022). After the cross-section dependence test (Pesaran, 2020), the stationarity of the variables must be determined. The CADF and Im, Pesaran, and Shin (CIPS) tests (Pesaran, 2007), which can manage the cross-sectional dependency problem, are chosen for this purpose.

3.8.8 Panel Cointegration Test

These tests may be divided into two groups, and seven alternative co-integration statistics are presented to represent the within- and between-effects in his panel. The first category consists of four tests that pool data along the 'within' dimension (for the unit-root test on the residuals, pooling the AR coefficients across several panel sections). These tests, which entail calculating average co-integration test results for a time series model throughout the various parts, are like those that were previously addressed. The purpose of panel cointegration analyses is to examine the presence of a long-term link within variables in a panel dataset. To analyze the cointegration relation in a panel analysis, it is sufficient to show that the relevant variables are not level stationary (*Erdem ,2012*). The panel cointegration test was utilized to examine the long-term relationship between variables. This test is valuable for elucidating the heterogeneity relationships, both long- and short-term, and fixed effects across the entire panel. The link between greenhouse gas emissions, green growth, financial risk, renewable energy, and other factors over the long term is examined using the Pedroni test for cointegration and the Kao Panel cointegration test. (Kao et al., 1999; Pedroni , 2004).

If the significance value in both Pedroni and Kao tests is less than 0.05 If the p-value is less than 0.05, then the null hypothesis should be rejected in favor of the alternative hypothesis of the existence of cointegration in the variable in the model, and if the significance value is more significant than 0.05 ($p<0.05$), admit the null hypothesis of no cointegration in the model (Kao et al., 1999; Pedroni, 2004).

3.8.9 Fully Modified, Ordinary Least Square,

The FMOLS estimation method is especially advantageous when dealing with cointegrated panels because it addresses two main issues: endogeneity bias and serial correlation. By considering these factors, FMOLS provides estimators of the long-term connection that are both dependable and accurate. When dealing with cointegrated panels that are not homogeneous, FMOLS is the preferred approach, in which the cointegration relationship may vary across individuals or cross-sections. 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).

FMOLS emerges as a robust method for estimating cointegrating relationships in heterogeneous panel data by contrasting property asymptotic of different estimators based on aggregating through its "inside" and "between" dimensions, respectively. It overcomes endogeneity bias and serial correlation, permitting consistent and efficient estimation of the long-run relationship between variables when cointegrated panels are present (Pedroni, 2001).

3.8.10 Panel Dynamic Ordinary Least Squares

The PDOLS estimator is a method that extends the Dynamic Ordinary Least Squares (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. The addition of 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).

3.9 Conceptual Framework/Econometric Model

The conceptual framework serves as the project's overall theoretical framework. It is a network of relationships among the variables determined to be pertinent to the issue scenario and found by procedures like observation, interviews, and literature surveys that have been rationally established, documented, and elaborated.

3.9.1 Model 1

$$FR_{it} = \beta_0 + \beta_1 GHG_{it} + \beta_2 GG_{it} + \beta_3 RE_{it} + \beta_4 TI_{it} + \beta_5 FI_{it} + \beta_6 SI_{it} + \mu_i + \epsilon_{it} \quad (1)$$

$$FR_{it} = \beta_0 + \beta_1 GHG_{it} + \beta_1 GG_{it} + \beta_2 TI_{it} + \beta_3 FI_{it} + \beta_4 RE_{it} + \beta_5 ST_{it} + CURB + CIND + CLL + \mu_i + \epsilon_{it} \quad (2)$$

3.9.2 Model 2

$$GHG_{it} = \beta_0 + \beta_1 FR_{it} + \beta_1 GG_{it} + \beta_2 TI_{it} + \beta_3 FI_{it} + \beta_4 RE_{it} + \beta_5 ST_{it} + \mu_i + \epsilon_{it} \quad (2)$$

$$GHG_{it} = \beta_0 + \beta_1 GHG_{it} + \beta_2 GG_{it} + \beta_3 RE_{it} + \beta_2 TI_{it} + \beta_3 FI_{it} + \beta_5 ST_{it} + CURB + CIND + CLL + \mu_i + \epsilon_{it} \quad (2.1)$$

3.10 Model Specification

3.10.1 Model 1 Specification

This model shows the impact of greenhouse gas, technological innovation, financial inclusion, green growth, Renewable energy, and soft infrastructure on Financial Risk. Model 1.1 is an extension of model 1, which includes the control variables. What do the letters I and t mean individual nations and eras, correspondingly. The erroneous term is (μit). β is the vector for the dependent variable as GHGs=Greenhouse Emissions, and for independent variables as FR= Financial Risk, GG= Green Growth, RE= Renewable energy, TI= Technological Innovation, FI= Financial Inclusion, ST= Soft infrastructure while control variables as URB= Urbanization, PG= Population Growth, IND= Industrialization, LL= Literacy level What the letters I and t mean individual nations and eras, correspondingly. The erroneous term is (μit). β is a vector for the independent variables. Where C represents the controlled variables.

3.10.2 Model 2 Specification

This model shows the nexus between greenhouse gases emission and financial risk with the role of green growth, financial inclusion, Renewable energy, and soft infrastructure. Model 2.1 is an extension of Model 2, which includes control variables, What the letters I and t mean individual nations and eras, correspondingly. The erroneous term is (μit). β is vector for the dependent variable as GHGs=Greenhouse Emissions, and for independent variables as FR= Financial Risk, GG= Green Growth, RE= Renewable energy, TI= Technological Innovation, FI= Financial Inclusion, ST= Soft infrastructure while control variables as URB= Urbanization, PG= Population Growth, IND= Industrialization, LL= Literacy level. Meanings of "I" and "t" individual nations and eras, respectively. The erroneous term is (μit). β is a vector for the independent variables. Where C represents the controlled variables.

Chapter 4

Results and Analysis

4.1 Introduction

The "Results and Analysis" chapter provides an in-depth review of the collected data and an in-depth exploration of the findings. It offers a concise summary of the statistical results derived from the study, highlighting the most significant patterns, relationships, and trends observed in the data. Through rigorous analysis, this chapter seeks to uncover insights and draw meaningful conclusions regarding the research queries or hypotheses under consideration. It provides a critical interpretation of the results, considering their implications and significance within the larger context of the study. This chapter is essential for comprehending the significance of the research's findings in advancing the field's body of knowledge. Stata 17 software was utilized for statistical analysis, allowing for a rigorous examination of interactions, patterns, and significant findings in the collected data to investigate the research questions.

4.2 Descriptive Statistics

Each variable included 1776 observations of a period ranging from 2004 to 2019 for 111 countries. The Descriptive statistics of the dataset report the range mean, median, of the data of the variables. The descriptive statistics result shows that the greenhouse gases have a mean value of 11.3, the range of greenhouse gases is 16.358, and the standard deviation is 1.32. The descriptive statistic of financial risk reports a mean of 16.65, the range is 97.937, and the standard deviation of financial risk is 12.006. The statistics for green growth show a range of around .00256 with a mean value of .00285 and a standard deviation of 00323.

Table 4.1 Descriptive Statistics Model 1

Variable	Orbs	Mean	Std. Dev.	Min	Max
GHG	1776	11.3	1.632	7.539	16.358
FR	1776	16.165	12.006	0.183	97.937
GG	1776	0.0029	0.0032	3.30E-06	0.0026
TI	1776	3.327	0.903	0.088	4.427
RE	1776	2.763	1.168	0.01	4.605
FI	1776	3.078	1.002	0.003	4.854
SI	1776	13.126	2.785	3.258	20.201
CVLL	1776	4.439	0.373	2.164	5.099
CPG	1776	0.898	0.859	0	8.517
CUG	1776	4.091	0.421	2.697	4.605
CVI	1776	3.258	0.366	1.516	4.315
est re	1776	1	0	1	1
est fe	1776	1	0	1	1

The descriptive statistics of renewable energy show a mean value of 2.763, a range of 4.427, and a divergence from the norm value is 1.168. The dataset reports an average value of 3.327, having a range of 5.996, and the standard deviation is .903 for technological innovation. The descriptive financial inclusion statistics show a mean value of 3.078, a range of 4.854, and a standard deviation of 1.002 soft infrastructure has a mean of 13.126, with a standard deviation value of 2.785 and a range of 20.201.

4.3 Correlations

The correlation matrix shows how closely related the variables are to one another in terms of each pair listed along the top and left-hand sides of the matrix. The diagonal line of the matrix represents the correlation between a variable and itself, which is always equal to 1. The values in the matrix range the correlation coefficient scales from -1 to 1. There is no correlation if the value is 0, and there is a perfect positive correlation if the value is 1.

Upon examination of the correlation matrix, it is evident that technological innovation

(TI), financial inclusion (FI), and soft infrastructure (SI) (0.228*, 0.076*, and 0.611*) have significant positive correlations with greenhouse gases (GHG) at p0.01. This indicates a distinct positive relationship between these factors and greenhouse gas emissions. In other words, technological innovation, financial inclusion, and soft infrastructure will be associated with increased greenhouse gas emissions.

Table 4.2 Correlation Matrix

	GHG	FR	GG	TI	RE	FI	SI	CVLL	CPG	CUG	CVI
GHG	1										
FR	-0.011*	1									
	-0.063										
GG	-0.591*	-0.04	1								
	0	0									
TI	0.228*	0.197*	0.182*	1							
	0	0	0								
RE	-0.290*	-0.054*	-0.114*	-0.163*	1						
	0	0	0	0							
FI	0.076*	0.376*	0.113*	0.519*	-0.243*	1					
	-0.001	0	0	0	0						
SI	0.611*	0.207*	0.408*	0.446*	-0.272*	0.494*	1				
	0	0	0	0	0	0					
CVLL	0.047*	0.283*	-0.035	0.400*	-0.266*	0.644*	0.481*	1			
	-0.047	0	-0.136	0	0	0	0				
CPG	-0.115*	0.122*	-0.066*	0.054*	-0.027	0.111*	-0.086*	-0.018	1		
	0	0	0	0	-0.259	0	0	-0.437			
CUG	0.164*	0.293*	0.075*	0.347*	-0.357*	0.572*	0.414*	0.634*	0.017	1	
	0	0	-0.002	(0.000	0	0	0	0	0		
CVI	0.193*	-0.111*	0.038	-0.150*	-0.080*	-0.242*	-0.044	-0.015	-0.061*	0.032	1
	0	0	-0.11	0	0	0	-0.06	-0.53	-0.01	-0.17	

*** p< 0.01, ** p< 0.05, * p< 0.1

There is a significant negative correlation (-0.011, -0.59* -0.29*, p 0.01) across greenhouse gases (GHG) and both financial risk (FR) and renewable energy (RE), and green growth, as shown by the correlation matrix. This indicates that greenhouse gas emissions tend to decline as financial risk and renewable energy increase.

4.4 Regression Analysis

This step of data regression analysis was conducted using STATA-17 software to analyze the effect of (FR), (GG), (TI), (RE), and (SI) on (GHG) in 111 countries. The data's variability can be determined using the R-squared (R2) value. In this instance, the R-squared value derived is 64.7%, indicating that the model is suitable for further analysis. The R-squared value of 64.7% in this context indicates that approximately 64.7% of the variability in the predictor variables by the model's set of independent variables.

Table 4.3 Linear regression

GHG	Coef.	St. Err	t-value	p-value	[95% Conf	Interval]	Sig
FR	-0.006	0.002	-2.77	0.006	-0.01	-0.002	***
GG	-1.833	7.754	23.01	0.00	1.283	1.947	***
TI	0.137	0.031	4.38	0.00	0.075	0.198	***
RE	-0.235	0.021	-10.94	0.00	-0.277	-0.193	***
FI	-0.248	0.036	-6.83	0.00	-0.319	-0.177	***
SI	0.337	0.011	30.08	0.00	0.315	0.359	***
CVLL	-1.078	0.093	-11.63	0.00	-1.26	-0.897	***
CPG	-0.096	0.028	-3.48	0.001	-0.151	-0.042	***
CUG	0.121	0.077	1.56	0.118	-0.031	0.272	
CVI	0.747	0.067	11.06	0.00	0.614	0.879	***
Constant	9.356	0.406	23.06	0.00	8.56	10.152	***

Mean dependent var	11.3	SD dependent var	1.632
R-squared	0.647	Number of obs	1776
F-test	323.895	Prob > F	0
Akaike crit. (AIC)	4949.321	Bayesian crit. (BIC)	5009.624

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

In general, a more excellent R-squared value implies a better model fit, indicating that the independent variables explain a more proportionately large amount of variation in the dependent variable.

However, the adequacy of the R-squared value as a measure of model fit may vary across disciplines and research questions; therefore, it is prudent to consider additional criteria and statistical tests to evaluate the model's overall validity and robustness. Multiple independent variables, namely FR, GG, TI, RE, FI, and SI, have statistically significant effects on the dependent variable (GHG), as indicated by p-values less than 0.06. Notably, FR, RE, GG, and FI exhibit significant negative coefficients with p-values less than 0.05 (-0.006, -0.235, -1.833, and -0.248, respectively), indicating that an increase in these variables is associated with a decrease in greenhouse gases (GHG). In addition, TI, and SI exhibit significant positive coefficients of 0.137 and 0.337, respectively, with p-values less than 0.05, indicating that a rise in technological innovation and soft infrastructure has been correlated with increased GHG emissions.

4.5 Multicollinearity

The Variance Inflation Factor (VIF) is used to assess the degree of multicollinearity among independent variables in a regression model. Generally, a VIF value of 10 or higher is often considered a threshold for determining the presence of significant multicollinearity (Jou et al., 2014). In this study, the VIF values of all variables in the regression model are less than 3, which is acceptable. This suggests that multicollinearity is insignificant in this model. In addition, the mean VIF value of 1.428 is below 2, supporting the conclusion that multicollinearity does not pose a significant problem for this regression model.

Table 4.4 Variance Inflation Factor

Variable	*VIF*	*1/VIF*
FI	2.7	0.370041
CVLL	2.57	0.388462
CHD	2.51	0.398225
CUG	2.07	0.483796
GHG	2.05	0.487816
TI	1.48	0.67344
GG	1.35	0.741307
FR	1.23	0.814508
RE	1.19	0.840068
CVI	1.17	0.854825
CPG	1.06	0.941023
Mean VIF	1.76	

4.6 Cross-Sectional Dependency

A cross-sectional dependency test is a statistical procedure used to determine whether there is a significant degree of dependence between the observations within a panel data set. This dependence occurs when the observations in the dataset are not independent of one another.

Table 4.5 Cross-Sectional Dependency

Variable	CD-TEST	P-Value	Average Joint T	Mean p	Mean abs(P)
-					
FR	13.92	0.00	16	0.04	0.39
GHG	19.505	0.00	16	0.06	0.67
GG	103.732	0.00	16	0.33	0.51
TI	13.868	0.00	16	0.04	0.38
RE	3.052	0.00	16	0.01	0.58
FI	54.456	0.00	16	0.17	0.59
SI	258.914	0.00	16	0.83	0.84
CPG	-0.624	0.533	16	0	0.39
CVLL	72.99	0.00	16	0.23	0.49
CUG	185.974	0.00	16	0.6	0.84
CVI	72.77	0.00	16	0.23	0.51

All variables examined in the study had p-values of 0.00, indicating significant evidence against the null hypothesis of cross-sectional independence. This indicates that the observations in the panel data set exhibit a significant degree of interdependence or relationship. The results indicate that changes or disruptions in one observation or unit will influence the remaining observations or units in the dataset. These results underscore the presence of cross-sectional dependence, emphasizing the independence or interrelationship of the investigated variables.

4.7 Hausman Test

The Hausman test is a statistical method for determining whether the fixed effects (FE) or random effects (RE) model is more appropriate for panel data analysis.

Hausman's (1978) specification test

P-value	0.000

The test yields a p-value of 0.0000, demonstrating the statistical significance of this difference. These results imply that the fixed effects (FE) model is more appropriate for the panel data analysis, whereas the random effects (RE) model may induce bias. In the study's appendix are tables exhibiting the outcomes of fixed effect and random effect analyses. These tables detail the estimated effects of variables, considering individual-specific traits and random variations.

4.8 Panel Unit Root Test

The CIPS and CADF tests are commonly used statistical tests to determine whether a dataset contains a unit root. A unit root indicates that the data is nonstationary and follows a random walk pattern, which means it lacks a stable mean and displays persistent changes over time. Consequently, the CIPS and CADF tests play a crucial role in assessing the stationarity properties of a dataset, allowing researchers to determine if the additional analysis should account for nonstationary and the potential random walk behavior exhibited by the data.

Table 4.6 Panel Unit Root Test

Panel Unit Root Test				
	Pesaran's CADF		CIPS unit root	
Variables	I (0)	I (1)	I (0)	I (1)
GHG	-1.879	-3.563***	-1.879	-3.563***
FR	-1.866	-3.369***	-1.866	-3.369***
GG	-2.007***		-2.007***	
TI	-1.948	-3.634***	-1.948	-3.634***
RE	-1.785	-3.356***	-1.785	-3.356***
FI	-1.893	-3.386***	-1.893	-3.386***
SI	-3.624***		-3.624***	

Critical values for CIPS 1%=, -2.4 5%=-2.5 , 10%= -2.6 And for CADF critical values at 1%=-2.3 5%=-2.4 and 10%=-2.6 respectively.

After analyzing the results of the CIPS and CADF tests, all panel variables are nonstationary, indicating that the null hypothesis is accepted at the I (0) level. The null hypothesis of nonstationary is rejected in favor of the alternative hypothesis of stationarity when the variables are differentiated once (I (1)). Consequently, the according to the findings, the variables maintain a steady state when analyzed at the first difference.

4.9 Panel Cointegration

The table reports the results of Wester Lund's (2007) and Padroni's cointegration test, which is used to evaluate long-term association among variables. The results of both tests show that the null hypothesis of "no cointegration" is rejected at 1%, signifying a long-term relationship among all variables in the model.

4.9.2 Pedroni Cointegration

The Panel Cointegration test used the Padroni test to fix whether the variables have a long-term affiliation. The results indicate that cointegration exists.

Table 4.7 Pedroni Cointegration

Table	Pedroni	Panel Cointegration	
	T Statistic	p-value	Decision
M Phillips Perron t	13.8343	0	"Cointegration Exists"
Phillips Perron t	-10.9345	0	"Cointegration Exists"
A Dickey-Fuller t	-9.7373	0	"Cointegration Exists"

The M Phillips Perron test produced a T statistic of 13.8343 with a significance level 0.000. This strongly suggests co-integration, suggesting a long-term relationship between the variables. With a T statistic of -9.1397 and a p-value of 0.000, the Phillips-Perron test also supported the presence of cointegration. These results support the notion that the variables have a long-term relationship. A Dickey-Fuller test demonstrated cointegration with a T statistic of -8.0614 and a p-value of 0.000. This suggests that the variables are not entirely random and have a long-term relationship.

We can confidently conclude that the variables exhibit cointegration. This suggests a stable and long-term relationship between the variables and that alterations to one variable will have enduring effects on the others. These findings have significant implications for comprehending the dynamics and interdependencies of the investigated variables. The T statistic represents the value of the test statistic, while the p-value indicates the level of significance related to the test. In each of the three analyses, the p-values are extremely small (p 0.001), indicating substantial evidence against the null hypothesis of no cointegration. Therefore, based on the p-values, we can conclude that panel data cointegration exists.

4.10 Panel Fully Modified Ordinary Least Squares

The value of R-squared (0.552689) quantifies the extent to which the predictor variables in a regression model account for the variance in the dependent variable. In this case, the independent variables explain approximately 55.27% of the variation in the dependent variable. The modified R-squared (0.550155) adjusts the R-squared value to accommodate the number of independent variables. The adjusted R-squared in this instance is extremely near to the R-squared value. The dependent variable has a mean of 11.33294 and a standard deviation of 11.83264. The regression's standard error (0.104540) estimates the average distance between the actual values of the dependent variable and the predicted values from the regression model and the values predicted by the regression model. A lesser standard error indicates the model's ability to explain the data better. the sum of squared residuals is 16.05428. The long-run variance of the dependent variable is 0.025573, representing its long-term variability. It offers information regarding the stability and volatility of the variable over time. The analysis results revealed significant associations between variables and greenhouse gas (GHG) emissions. The coefficient of -0.000143 demonstrates that the relationship between variable FR and GHG emissions is statistically significant. Although weakly statistically significant at the 10% level (p-value = 0.0815), higher FR values appear to correspond to lower GHG emissions. In contrast, the variable GG exhibits a statistically significant negative relationship, with a coefficient of -5.695605, suggesting that there has been a rise GG is associated with decreased GHG emissions. This association is statistically significant at the 5% level (p-value = 0.017), highlighting the substantial impact of GG on GHG emissions.

Moreover, the analysis reveals that the variable TI has a statistically significant influence on greenhouse gas emissions. The negative coefficient of -0.030229 and the p-value of 0.0201 indicate a negative correlation, indicating that greater TI values are associated with lower GHG emissions.

Table 4.8 Panel Fully Modified Ordinary Least Squares

GHG Variable	Coefficient	Std. Error	t-Statistic	Prob.
FR	-0.000143	0.000613	-0.233327	0.0815
GG	-5.695605	4.149617	1.372562	0.0170
TI	0.030229	0.012986	2.327769	0.0201
RE	-0.132910	0.014150	-9.393242	0.0000
FI	0.057379	0.016461	3.485640	0.0005
SI	0.029942	0.004783	6.260303	0.0000
CPG	-0.006443	0.007668	-0.840229	0.4009
CVI	0.113298	0.041922	2.702576	0.0070
CUG	0.766301	0.153708	4.985419	0.0000
CVLL	-0.061792	0.035794	-1.726314	0.0845

R-squared	0.552689	Mean dependent var	11.33871
Adjusted R-squared	0.550155	S.D. dependent var	1.632528
S.E. of regression	0.104540	Sum squared resid	16.05428
Long-run variance	0.025573		

The relationship is statistically significant at the 5% level of statistical significance. In addition, RE has a statistically significant inverse relationship with greenhouse gas emissions. As indicated by the coefficient of -0.132910 and the exceedingly low p-value of 0.0001, which indicates statistical significance at the 1% level, GHG emissions decrease as RE increases.

Similarly, the variable FI exhibits a statistically significant positive relation with GHG emissions, as measured by a coefficient of 0.057379. The relationship between an increase in FI and higher GHG emissions is statistically significant at the 5% level, as indicated by the p-value of 0.0005. SI has a statistically significant positive relationship with GHG emissions, as measured by a coefficient of 0.029942. The 0.00001 p-value demonstrates the statistical significance of this relationship. This analysis indicates the statistically significant relationships between FR, GG, TI, RE, FI, and SI and GHG emissions.

4.11 Panel Dynamic Ordinary Least Squares

The R-squared value of 0.580229 indicates that approximately 58% of the variation in the dependent variable can be explained by the independent variables included in the regression model. While mean of the dependent variable, GHG is 11.29986, representing the average amount of GHG emissions in the data set. The standard deviation of the dependent variable is 1.631627, which represents the variance or dispersion of GHG emissions around the mean. After that standard error of the regression (S.E. of regression) is 0.111450, which represents the average difference between the actual GHG emissions, and the values predicted by the regression model. The sum of squared residuals is 20,5568, representing the total squared difference between actual GHG emissions and model-predicted values.

This variance provides insight into the long-term variability of GHG emissions. Long-term variability is quantified by a value of 0.027332 corresponding to the long-run variance. A reduced long-term variance indicates that GHG emissions are less variable and more stable. In this case, GHG emissions are anticipated to exhibit lesser fluctuations and a more consistent pattern over time. The analysis reveals significant correlations between various variables and greenhouse gas (GHG) emissions. Variable FR exhibits a statistically significant relationship (p-value = 0.0660) with a positive coefficient of 0.000259, indicating a possible positive association with GHG emissions. Similarly, the variable GG has a negative statistically significant relationship (p-value = 0.0345) with GHG emissions, as indicated by its coefficient of -3.9234. These findings suggest that increases in FR are associated with greater greenhouse gas emissions.

Table 4.9 Panel Dynamic Ordinary Least Squares

Variable GHG	Coefficient	Std. Error	t-Statistic	Prob.
FR	0.000259	0.000589	0.439215	0.0660
GG	-3.9234	4.1537	0.944558	0.0345
TI	0.023349	0.012661	1.844156	0.0653
RE	-0.099539	0.012282	-8.104620	0.0000
FI	0.071974	0.015072	4.775372	0.0000
SI	0.021691	0.004221	5.139232	0.0000
CPG	-0.005775	0.007490	-0.771077	0.4408
CVI	0.100839	0.036993	2.725859	0.0065
CUG	0.891576	0.133463	6.680314	0.0000
CVLL	-0.038698	0.032410	-1.194035	0.2326

R-squared	0.580229	Mean dependent var	11.29986
Adjusted R-squared	0.577612	S.D. dependent var	1.631627
S.E. of regression	0.111450	Sum squared resid	20.55680
Long-run variance	0.027332		

Moreover, the variable TI has a limited statistical significance (p-value = 0.0653) and a negative coefficient of -0.023349, indicating a possible inverse relationship with GHG emissions. Despite the need for additional research to ascertain the intensity and significance of this association, it suggests that an increase in TI may be associated with a decrease in GHG emissions. In contrast, variable RE demonstrates a statistically significant inverse relationship (p-value 0.01) with GHG emissions, denoted by its coefficient of -0.099539. This result indicates that as RE increases, GHG emissions decrease, highlighting the importance of RE in mitigating GHG emissions.

In addition, the variable FI exhibits a statistically significant positive correlation (p-value 0.01) with GHG emissions, with a coefficient of 0.071974. This suggests that a rise in FI is related to increased GHG emissions. Similarly, the SI variable exhibits a statistically significant positive correlation (p-value 0.01) with GHG emissions.

4.12 Descriptive Statistics

Each variable included 1776 observations of a period ranging from 2004 to 2019 for 111 countries.

Table 4.10 Descriptive Statistics Model 2

Variable	Obs	Mean	Std. Dev.	Min	Max
country	1,776	56	32.05066	1	111
year	1,776	2011.5	4.611071	2004	2019
GHG	1,776	11.29986	1.631627	7.539027	16.35751
FR	1,776	2.510978	0.789434	0.0139404	4.584321
GG	1,776	0.0000402	0.0000867	3.30E-06	0.0007651
TI	1,776	3.327152	0.9033494	0.0880996	4.427459
RE	1,776	13.12623	2.785121	3.258096	20.20147
FI	1,776	2.763331	1.16752	0.0100503	4.60517
SI	1,776	3.077763	1.002081	0.0028419	4.853731
CVLL	1,776	4.438932	0.3734862	2.164078	5.099468
CPG	1,776	0.8979694	0.8587755	0.0001288	8.516529
CUG	1,776	4.09068	0.4213696	2.697394	4.60517
CVI	1,776	3.25783	0.365574	1.516429	4.314981

The Descriptive statistics of the dataset report the range, mean, and standard deviation of the data of the variables. The descriptive statistics result shows that the greenhouse gases have a mean value of 11.3, the range of greenhouse gases is 16.358, and the standard deviation is 1.32. The descriptive statistic of financial risk reports a mean of 16.65, the range is 97.937, and the standard deviation of financial risk is 12.006. The statistics for green growth show a range of around .00256 with a mean value of .00285 and a standard deviation of 00323. The descriptive statistics of Renewable energy show a mean value of 2.763, a range of 4.427, and a value relative to the norm is 1.168. The dataset reports a mean value of 3.327, having a range of 5.996, and the standard deviation is .903 for technological innovation. The descriptive statistics of financial inclusion show a mean value of 3.078, a range of 4.854, and a standard deviation of 1.002. soft infrastructure having a mean of 13.126, the standard deviation value is 2.785, and the range of 20.201.

4.13 Correlations

The correlation matrix displays the pairwise correlation coefficients between the variables listed along the top and left-hand sides of the matrix. The diagonal line of the matrix represents the correlation between a variable and itself, which is always equal to 1. The values in the matrix range from -1 to 1, where -1 represents an absolutely negative correlation, 0 a neutral one, and 1 a completely positive one.

There is a significant negative correlation (-0.011, -0.59* -0.29*, p 0.01) across greenhouse gases (GHG) and both financial risk (FR) and renewable energy (RE), and green growth, as shown by the correlation matrix. This indicates that greenhouse gas emissions tend to decline as financial risk and renewable energy increase.

Upon examination of the correlation matrix, it was evident that technological innovation (TI), financial inclusion (FI), and soft infrastructure (SI) (0.228*, 0.076*, and 0.611*) have significant positive correlations with greenhouse gases (GHG) at p 0.01. This indicates a distinct positive relationship between these factors and greenhouse gas emissions. In other words, technological innovation, financial inclusion, and soft infrastructure will be associated with increased greenhouse gas emissions.

Table 4.11 Pairwise correlations

	FR	GHG	GG	TI	RE	FI	SI	CPG	CVLL	CUG	CVI
FR	1										
GHG	-0.011*	1									
	-0.0634										
GG	- 0.121*	0.312*	1								
	0	0									
TI	0.197*	0.228*	0.059*	1							
	0	0	-0.013								
RE	-0.054*	-0.290*	-0.062*	-0.163*	1						
	-0.023	0	-0.009	0							
FI	0.376*	0.076*	0.025	0.519*	-0.243*	1					
	0	-0.001	-0.288	0	0						
SI	0.207*	0.611*	0.212*	0.446*	-0.272*	0.494*	1				
	0	0	0	0	0	0					
CPG	0.122*	-0.115*	-0.073*	0.054*	-0.027	0.111*	-0.086*	1			
	0	0	-0.002	-0.023	-0.259	0	0				
CVLL	0.283*	0.047*	-0.03	0.400*	-0.266*	0.644*	0.481*	-0.018	1		
	0	-0.047	-0.207	0	0	0	0	-0.437			
CUG	0.293*	0.164*	0.075*	0.347*	-0.357*	0.572*	0.414*	0.017	0.634*	1	
	0	0	-0.002	0	0	0	0	-0.482	0		
CVI	-0.111*	0.193*	0.117*	-0.150*	-0.080*	-0.242*	-0.044	-0.061*	-0.015	0.032	1
	0	0	0	0	-0.001	0	-0.061	-0.01	-0.532	-0.17	

*** p<0.01, ** p<0.05, * p<0.1

4.14 Regression Analysis

In this step of data regression analysis was conducted using STATA-17 software to analyze the effect of financial risk (FR), Green Growth (GG), technological innovation (TI), renewable energy (RE), and soft infrastructure (SI) on greenhouse emissions (GHG) of 111 countries. The regression model has an overall R2 of 0.324, which means that the independent variables explain 32.4% of the variation in the dependent variable. Additionally, the F-test indicates the model's overall statistical significance. However, it is essential to observe that a deeper contextual understanding of the specific variables and their relationships would aid in interpreting these results.

In general, a greater R-squared value implies a better model fit, indicating that the independent variables explain a greater proportion of the total variation in the thing being dependent. However, the adequacy of the R-squared value as a measure of model fit may vary across disciplines and research questions; therefore, it is prudent to consider additional criteria and statistical tests to evaluate the model's overall validity and robustness. The regression analysis results shed light on the relationship between the two sets of variables. GHG has a statistically significant negative coefficient of -0.764, suggesting that a decline in GHG corresponds with a decrease in the dependent variable.

Table 4.12 Linear regression

FR	Coef.	St. Err.	t-value	p-value	[95% Conf	Interval]	Sig
GHG	-0.764	0.275	-2.77	0.006	-1.304	-0.224	***
GG	3.863	1.049	3.68	0	1.805	5.922	***
TI	-1.442	0.362	-3.98	0	-2.152	-0.732	***
RE	-0.319	0.257	-1.24	0.215	-0.824	0.185	
FI	2.46	0.423	5.82	0	1.631	3.29	***
SI	0.375	0.159	2.35	0.019	0.062	0.687	**
CVLL	-0.568	1.116	-0.51	0.611	-2.756	1.621	
CPG	1.3	0.321	4.05	0	0.671	1.93	***
CUG	4.14	0.89	4.65	0	2.394	5.886	***
CVI	0.4	0.809	0.49	0.621	-1.187	1.987	
Constant	-0.006	5.369	0	0.999	-10.535	10.524	

Mean dependent var	16.165	SD dependent var	12.006
R-squared	0.324	Number of obs	1776
F-test	24.906	Prob > F	0
Akaike crit. (AIC)	13654.794	Bayesian crit. (BIC)	13715.097

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

GG has a highly significant positive coefficient of 3.863, indicating that an increase in GG results in an increase in the dependent variable. In addition, TI has a significant negative coefficient of -1.442, indicating that a decrease in TI corresponds to a decrease in the dependent variable. In contrast, the RE variable lacks statistical significance, indicating that it may not substantially affect the dependent variable. Moreover, the FI and SI variables have statistically significant positive result coefficients, representing that these variables correlate to increases in the dependent variable.

4.15 Multicollinearity

The Variance Inflation Factor (VIF) assesses the degree of multicollinearity among independent variables in a regression model. Generally, a VIF value of 10 or higher is often considered a threshold for determining the presence of significant multicollinearity (Jou et al., 2014).

Table 4.13 Variance inflation factor

Variable	VIF	1/VIF
FI	2.7	0.370041
CVLL	2.57	0.388462
CHD	2.51	0.398225
CUG	2.07	0.483796
GHG	2.05	0.487816
TI	1.48	0.67344
GG	1.35	0.741307
FR	1.23	0.814508
RE	1.19	0.840068
CVI	1.17	0.854825
CPG	1.06	0.941023
Mean VIF	1.76	

In this study, the VIF values of all variables in the regression model are less than 3, which is acceptable. This suggests that multicollinearity is insignificant in this model. In addition, the mean VIF value of 1.428 is below 2, supporting the conclusion that multicollinearity does not pose a significant problem for this regression model.

4.15 Cross-Sectional Dependency

A cross-sectional dependency test is a statistical procedure applied to the question of there is a significant degree of dependence between the observations within a panel data set. This dependence occurs when the observations in the dataset are not independent of one another.

Table 4.14 Cross-Section Dependency

Variable	CD - test	p-value	average joint T	mean ρ	mean abs(ρ)
GHG	20.500	0.00	16	0.06	0.67
FR	19.505	0.00	16	0.05	0.39
GG	14.525	0.00	16	0.36	0.52
TI	113.321	0.00	16	0.04	0.38
SI	13.868	0.00	16	0.83	0.84
RE	258.914	0.002	16	0.01	0.58
FI	3.052	0.00	16	0.17	0.59
CVLL	54.456	0.00	16	0.23	0.49
CPG	72.99	0.533	16	0	0.39
CUG	-0.624	0.00	16	0.6	0.84
CVI	185.974	0.00	16	0.23	0.51

All variables examined in the study had p-values of 0.00, indicating significant evidence against the null hypothesis of cross-sectional independence. This indicates that the observations in the panel data set exhibit a significant degree of interdependence or relationship. The results indicate that changes or disruptions in one observation or unit will likely influence the remaining observations or units in the dataset. These results underscore the presence of cross-sectional dependence, emphasizing the independence or interrelationship of the investigated variables.

4.17 Hausman Test

`The Hausman test is a statistical method for determining Whether it's better to analyses panel data using a fixed effects (FE) or random effects (RE) model. This test investigates the disparity between the estimated coefficients of the two models to determine whether the disparity is due to random fluctuations or a consistent bias.

Hausman's (1978) specification test

P-value	0.000

The test yields a p-value of 0.0000, demonstrating the statistical significance of this difference. In addition, the coefficients derived from the fixed effects model are consistent with both the null and alternative hypotheses (Ha). In contrast, the coefficients derived from the random effects model are only consistent with the null hypothesis. These results imply that the fixed effects (FE) model is more appropriate for the panel data analysis, whereas the random effects (RE) model may induce bias. In the study's appendix are tables exhibiting the outcomes of fixed effect and random effect analyses. These tables detail the estimated effects of variables, considering individual-specific traits and random variations.

4.18 Panel Unit Root Test

The CIPS and CADF tests are commonly used statistical tests to determine whether a dataset contains a unit root.

Table 4.15 Panel Unit Root Test

	Pesaran's CADF		CIPS unit root	
Variables	I (0)	I (1)	I (0)	I (1)
GHG	-1.879	-3.563***	-1.879	-3.563***
FR	-2.13	-3.416***	-2.13	-3.416***
GG	-2.007***		-2.007***	
TI	-1.948	-3.634***	-1.948	-3.634***
RE	-1.785	-3.356***	-1.785	-3.356***
FI	-1.893	-3.386***	-1.893	-3.386***
SI	-3.624***		-3.624	

Critical values for CIPS 1%=-2.4 5%=-2.5, 10%= -2.6 And for CADF critical values at 1%=-2.3 5%=-2.4 and 10%=-2.6 respectively.

A unit root indicates that the data is nonstationary and follows a random walk pattern, which means it lacks a stable mean and displays persistent changes over time. Consequently, the CIPS and CADF tests contribute much to assessing the stationarity properties of a dataset, allowing researchers to determine if the additional analysis should account for nonstationary and the potential random walk behavior exhibited by the data.

After analyzing consequences of the CIPS and CADF tests, all panel variables are nonstationary, indicating that the null hypothesis is accepted at the I (0) level. The null hypothesis of nonstationary is rejected in favor of the alternative hypothesis of stationarity when the variables are differentiated once (I (1)). Consequently, the findings suggest that the variables display a stationary conduct when analyzed at the first difference.

4.19 Panel Cointegration

The table reports the results of Wester Lund's (2007) and Padroni's cointegration test, which is used to evaluate long-term association among variables. The results of both tests show that the null hypothesis of "no cointegration" is rejected at 1%, signifying a long-term relationship among all variables in the model.

4.19.1 Padroni Cointegration

The Panel Cointegration test, specifically the Padroni test, was performed to check for a long-term correlation between the variables. The results of the test provide significant evidence of cointegration. The T statistic for the M Phillips Perron test was 13.8343, and the p-value was 0.000. This indicates a highly significant result, providing substantial evidence for cointegration's existence. Similarly, the T statistic for the Phillips Perron test was -9.1397 with a p-value of 0.000. This indicates a significant outcome, confirming further the existence of cointegration.

Table 4.16 Padroni test

Table	Panel Cointegration		
	T Statistic	p-value	Decision
M Phillips Perron t	13.8343	0	"Cointegration exists"
Phillips Perron t	-9.1397	0	"Cointegration exists"
A Dickey-Fuller t	-8.0614	0	"Cointegration exists"

The A Dickey-Fuller test also revealed a T statistic of -8.0614 and a p-value of 0.000. This significant result strengthens the case for cointegration. Based on the outcomes of all three analyses, it can be concluded that cointegration exists between the variables. This indicates a long-term relationship and interdependencies between the variables, implying that changes to one variable will have enduring effects on the others. These results have significant implications for comprehending the dynamics and relationship between the variables under consideration.

4.20 Panel Fully Modified Least Squares

A high R2 indicates that 0.665537 indicates that the regression model explains approximately 66.55% of the variation in the dependent variable. The value of adjusted R-squared for 0.638216 accounts for the number of model variables. The dependent variable has a mean of 16.00294 and a standard deviation of 11.83264. The regression's standard error is 7.117164, and the sum of squared residuals is 74407.77. The long-run variance is 90.86655, giving insight into the reliability and persistence of the variables' strong relationship.

This is an analysis of fully modified least square regression. The table displays the coefficients, standard errors, t-statistics, and probabilities associated with each regression model variable.

This variable's coefficient of 1.194362 indicates that an increase of one unit in GHG is associated with an increase in the dependent variable.

Table 4. 17 Panel Fully Modified Least Squares

Variable FR	Coefficient	Std. Error	t-Statistic	Prob.
GHG	1.194362	2.488763	0.479902	0.0063
GG	3.168313	2.474965	1.280145	0.0200
TI	-2.402690	0.772817	-3.109001	0.0019
RE	1.670171	0.893768	1.868685	0.0061
FI	1.941214	0.990405	1.960021	0.0502
SI	0.678363	0.289954	2.339556	0.0194
CPG	1.654187	0.454963	3.635869	0.0003
CVI	4.772595	2.507703	1.903174	0.0572
CUG	9.700753	9.393648	1.032693	0.3019
CVLL	-3.615598	2.131153	-1.696545	0.0900

R-squared	0.665537	Mean dependent var	16.00294
Adjusted R-squared	0.638216	S.D. dependent var	11.83265
S.E. of regression	7.117164	Sum squared resid	74410.77
Long-run variance	90.86655		

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At a significance level of 0.05, the t-statistic of 0.479902 indicates that the coefficient is statistically significant. This result is consent with (Tomiwa Sunday Adebayo 2022). The coefficient of 3.168313 for green growth indicates that an increase of one unit in green growth is associated with greater financial risk. The t-statistic of 1.280145 is statistically significant at the 0.05 level of significance. The result supports the finding of (Cao et al., 2022). With a coefficient of -2.402690, technological innovation is negatively correlated with financial risk. The t-statistic of -3.109001 indicates statistical significance at the 0.05 level of significance.

As indicated by the coefficient 1.670171, a single-unit renewable energy production growth corresponds to a one-unit increase in financial risk. The t-statistic of 1.868685 indicates statistical significance at the 0.05 level of significance. The coefficient of 1.941214 for financial inclusion indicates that an increase in financial inclusion results in a rise in financial risk. The t-statistic of 1.960021, however, indicates a marginal statistical significance (p-value = 0.0502). The soft infrastructure coefficient of 0.678363 indicates that there is a rise in SI linked with a decrease in financial risk. The t-statistic of 2.339556 indicates statistical significance at the 0.05 level of significance.

4.21 Panel Dynamic Ordinary Least Squares

Table 4.18 Panel Dynamic Ordinary Least Squares

Variable FR	Coefficient	Std. Error	t-Statistic	Prob.
GHG	1.0643459	2.189033	0.486217	0.0626
GG	1.7242348	2.408369	0.71593	0.0474
TI	-1.496047	0.733842	-2.038652	0.0416
RE	-2.4190559	0.739881	3.269519	0.0011
FI	1.8208965	0.885505	2.056338	0.0399
SI	0.3913238	0.248837	1.572609	0.0360
CPG	1.2691344	0.432143	2.936837	0.0034
CUG	4.8538396	7.976397	0.608525	0.0542
CVI	2.77343	2.153431	1.287915	0.1980
CVLL	-2.84845	1.877881	-1.516846	0.1295

R-squared	0.669221	Mean dependent var	16.16487
Adjusted R-squared	0.645237	S.D. dependent var	12.00599
S.E. of regression	7.151003	Sum squared resid	84631.48
Long-run variance	91.81949		

The R-squared value of 0.669221 demonstrates that the model's independent variables account for roughly 66.92% of the variance in FR. The modified R-squared value of 0.645237 reflects the number of model variables, while the mean of the variable being studied, FR, is 16.16487, which represents its average value in the data set. The standard deviation of the dependent variable is 12,00599, which represents the spread or variability of FR around the mean. The standard error of the regression (S.E. of regression) is 7.151003, providing a figure of the average distance among the observed FR values and the values forecast by the regression model. The sum squared residual is 84631.48, representing the sum of squared differences between the observed FR values and the model's predicted values. FR's long-term variability is reflected by the long-term variance of 91,81949. It represents the estimated variance of FR over a lengthy time. A more considerable long-run variance suggests that FR demonstrates greater fluctuations and volatility over time, indicating a less stable pattern.

The coefficient for GHG indicates that a one-unit increase in GHG is related to a 1.0643459-unit increase in FR. However, this link is only significant at the 10% level of significance. It shows weak relation between GHG and FR, while the one-unit rise in GG corresponds with a 1.7242348% increase in FR, according to the coefficient for GG. This relationship is statistically significant at the 5% level, indicating that GG significantly and positively affects FR. An increase of one unit in TI corresponds with a decrease of -1.496047 units in FR. This negative association is highly significant at the 0.05 level, suggesting that a higher TI is associated with a decreased FR. According to the coefficient for RE, a one-unit upsurge in RE is related with a 2.4194159-unit increase in FR. The significance of this positive connection at the 0.05 level indicates that RE has a major impact on FR. At the 5% level of significance, this connection is quite real. The coefficient for SI is 0.3913238, therefore a one-unit rise in SI corresponds to a 0.3913238-unit increase in FR. At the 5% significance level, this positive association is noteworthy.

4.22 Discussion

The study's objective is to investigate the impact of the Economic Indicator on sustainable development, having the data of 111 countries of the world by using the FMOLS and DOLS approaches to examine the long-term relationship. The study's findings reveal that the different green financial indicators impact sustainable development differently.

Model 1

This research shows that lowering carbon emissions and minimizing financial risks are mutually exclusive. To reduce carbon emissions without jeopardizing national stability and economic growth, policymakers will need to keep financial risks within manageable bounds and implement effective measures to counteract the inverse relationship between these dangers and emissions. Stable and orderly economic growth, as well as a decrease in carbon emissions, may be attained through increased technological innovation and the use of renewable energy.

Increases in either technological innovation or renewable energy usage reduce financial risk index carbon emission coefficient, suggesting that doing so contributes to the goal of lowering emissions contribute to achieving these goals (Q. Wang & Dong, 2022). We have discovered a substantial positive relationship between carbon emissions and economic stability. Greenhouse gas emissions have a substantial negative correlation with financial development. In contrast, countries with larger populations and higher urbanization rates experience increased carbon emissions (Afzal et al., 2022).

This study confirms in Table 4.8 and 4.9 that financial risk is negatively correlated with greenhouse gas emissions. In the long run, financial risk has a minimal coefficient, which means that an increase in financial risk will increase greenhouse gases, ultimately financial risk has an impact on renewable energy, green growth, technological innovation which increased greenhouse gas emissions. Controlling greenhouse gas emissions and, in the long run, financial risk has a positive relation. However, the long variance with other economic indicators has optimal results, meaning that more than controlling financial risk to greenhouse gases is required. Financial risk causes the roots of the nation with other economic indicators, financial risk, and greenhouse gases, both factors will control up somehow in the long run.

The global economy has expanded at the fastest rate in the 20th century, with unprecedented development in virtually every sector, but this prosperity has been accompanied by pollution. In consequence, the environment and livelihoods of residents have been in jeopardy for the past three decades, despite the expansion of industrial production. In addition to ensuring long-term financial stability, the government continues to exert significant efforts to clean up the environment and reduce environmental concerns.

The statistical findings demonstrate a negative correlation between environmental degradation and green growth. In the short and long term, a 1% change in GTRD results in a 0.35 and 0.48% decrease in environmental degradation at a 1% significance level (Wei et al., 2023). These results are consistent with this study. The coefficients of green growth are -5.695605 and -0.132910, respectively, indicating the cumulative effect of green growth on CO_2 emissions and highlighting the efficacy of global advocacy for a green economy. Businesses' green technological innovation processes have been sped up and industrial optimization and upgrading have been hastened as a result of the global economy's green transformation and expansion.

As the green movement has gained popularity, people have become more concerned about improving their quality of life and using less energy that produces a lot of pollution. The findings here are consistent with those of the research (C.-C. Lee & Lee, 2022), The emergence of green finance is sped up by the discovery of a negative correlation between green growth and greenhouse gas emissions. The local government's aggressive promotion and support of the green economy has prompted a widespread cultural shift in favor of sustainability, and green ideas are permeating every sector of society.

Renewable energy has a negative impact of 5% on CO_2 emissions in both the short and long term. This suggests that renewable energy reduces carbon dioxide emissions. Recent research has found a adverse correlation between renewable energy and carbon dioxide emissions, with the former alluding to the fact that the latter makes it possible for the world's top ten greenhouse gas emitters to reduce their carbon footprint (Tsimisaraka et al., 2023; J. Yu et al., 2022). Another study reveals a negative coefficient for renewable energy, indicating that it plays a significant role in decreasing consumption-based CO_2 emissions in BRI countries over time. Similar results are observed for renewable energy, indicating that, like fossil fuels, renewable energy has a statistically significant and negative relationship with CO_2 emissions in both short- and long-term models. (Cai & Wei, 2023).

Findings of the study tables 4.8 and 4.9. In line with the above results, renewable energy has a negative coefficient and significant impact on greenhouse gases, showing inverse relation to enhancing sustainable development; countries need to be enhanced the use of renewable energy instead of fossil fuel. Renewable energy has a high coefficient in both the model examined FMOLS and DOLS, showing that its high inverse impact on sustainable development.

According to this study's results, financial inclusion has a positive significant impact on sustainable development at the level of 5%. This result is consistent with the finding of (Tsimisaraka et al., 2023); the study reveals that inancial inclusion (FI) has a 5% positive long-term and short-term impact on CO_2 emissions in the nations. This means that as financial inclusion increases, so do CO_2 emissions. Increased availability to credit may have led to a surge in consumer spending on electronics like refrigerators, air conditioners, and televisions in the nations under study. Widespread adoption of these products hastens the consumption of fossil fuels for domestic energy production, leading to increased CO_2 emissions. It also shows how the countries distribute their money to get the results they want. To put it another way, advanced nations' resources have barely begun to develop. Assigning monetary assets for ecological damages and failing to push industrial units and organizations to use greener machinery are both reflected in the existence of a positive coefficient sign for financial inclusion. However, at the level of member states developing economies have a dynamic impact on ecosystem health.

The short-term and long-term effects of the soft infrastructure development on carbon emissions is statistically significant and favorably trending. An increase in soft infrastructure development results in a rise in energy demand, which in turn increases carbon emissions. Investment in soft infrastructure and hardware production will invariably increase energy consumption in the region (energy rebound effect), resulting in increased carbon emissions in the region. However, the hardware of soft infrastructure has a significant and positive effect on carbon emissions. The coefficient of the soft infrastructure is 0.029942 positive in the long run to examine the result FMOLS and DOLS conducted, and these results are aligned and confirm the study of (Cui et al., 2023). another study (X. Sun et al., 2023) verify that the coefficients of ICT in the entire sample appear to be statistically significant at the 5% significance level. We observe the effects of internet pervasiveness and mobile subscription. They imply that increasing internet penetration and mobile development are positively correlated with the environmental burden.

Model 2

4.22.2 Detailed Discussion for Model 2

This result is significant because financial instability allows businesses to invest in cutting-edge environmental technology that improves their energy efficiency and helps the environment by investing in renewable energy sources. A sound financing system that helps businesses buy cutting-edge green technology to boost production while lowering energy use and pollution. The results line up with what we expected and the corpus of prior research. The results of this study's investigation on the effect of financial stability on CO_2 emissions are similar to those of (Su et al., 2023).

Additionally, a decline in financial stability might endanger the financial system's overall strength. The country's economic growth is hampered by social and economic instability that results from volatility in the banking sector. Additionally, increased financial stability will affect how money is typically managed and increase investment uncertainty. Therefore, enhancing banking sector stability mitigates greenhouse gases in the world. This result agrees with the research of (Oyebanji et al., 2023).

Green growth is negatively correlated to financial risk, while in the long run, it is positively associated with financial risk. In both long-term models, green growth worldwide has shown a strong positive association. Green growth can be facilitated by 3.168313 units for each unit rise in financial risk. The nations spend 3.168313 units in green growth to reduce financial risk over the long term, with each nation incurring one unit of financial risk. The governments of numerous nations were dedicated to encouraging the active use of capital and expediting the modernization of the financial system, which was helpful in fostering the economy's rapid expansion. These results may be traced back to the investigation of (J. Zhao, Dong, et al., 2022).

With coefficient values of -1.496047 and -0.005, respectively, the data further implies that technological innovation and renewable energy affect drastically and adversely financial risk in the medium and long run. Our results lend credence to the argument that encouraging innovation in the field of renewable energy through government policy can be crucial to maintaining the environment. When the financial risk is going upward, the investment opportunity of the countries is going downward, so the main reason for the negative relationship between financial risk, renewable energy, and technological innovation findings of the study pivot the results of (Ahmad, Gavurova, et al., 2022).

Consistent with the findings of (Jima & Makoni, 2023) on the other hand, our study discovered a positive and substantial association between financial inclusion and financial stability (low non-performing loans and financial hardship), which is consistent with the findings of earlier studies (John & Rahut, 2015). Financial inclusion is greatly aided by stable financial institutions since they offer appropriate financial goods and services. Therefore, it is essential to create and implement appropriate policies and regulations that support financial inclusion and stability.

According to the findings, there is a long run co-integration between the relevant variables, namely financial inclusion, and financial stability. The study reveals that digital transformation, technological innovation significantly lowers corporate financial risk; there are substitution effects of internal control quality and marketization process on the suppression effect of digital transformation and corporate financial risk; More research shows that non-state-owned organizations and competitive industries benefit more from the suppressive effect of digital transformation on corporate financial risk, whereas high-tech businesses benefit more from the mitigating effect of digital transformation. Businesses may improve their development prospects and lower their financial risks by adopting a digital transformation plan (You & Zhao, 2023).

CHAPTER 5

CONCLUSION & RECOMMENDATION

This section wraps up the study's findings, highlighting the significant role of financial risk, green growth, and other economic indicators in encouraging carbon neutrality and advancing sustainable growth. Recommendations include expanding green growth mechanisms and implementing effective 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 financial risk and green growth's impact on sustainability.

5.1 Conclusion

The idea of sustainability has significantly increased in popularity over the past 30 years and has taken center stage in international forums. It has become a matter of utmost importance, necessitating the creation of a thorough framework for society and the economy that can successfully combine economic viability, social inclusion, and environmental sustainability. One of the most significant difficulties of our day is this duty. The most successful strategy for addressing the environmental issues that nations confront is to give priority to sustainable development. To address the substantial problems that have arisen because 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 financial risk green growth, renewable energy, technological innovation, financial inclusion, and soft infrastructure. 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 necessary in the modern era to accomplish the goal of sustainable development. The idea of funding projects with green bonds became widespread in 2008 and has seen consistent expansion since then.

Therefore, public authorities, who play a crucial role in collective regulation for long-term and equitable development, must adopt a new paradigm: Green Growth. In an effort to boost environmental quality, social welfare, and productivity, several governments have adopted new environmental and employment legislation over the past two decades. The most effective strategy for stopping global warming is to promote environmentally sustainable growth. While most prior research has concentrated on environmental quality's drivers, only a small fraction has looked at sustainable development from that perspective. To fill this gap in the literature, this study uses data collected from 2004-2019 to analyze the impact of green financial indicators on financial risk, green growth, and technological innovation in Sustainable development in 111 countries. The initial data diagnostic test confirmed the cross-sectional dependency among the variables. Tests for the Unit Root, generation 2 were performed to deal with the cross-sectional dependency among the variables. The findings of the second-generation unit root test (CIPS & CADF) and cointegration test (Pedroni) shows that most variables are stationary at the first difference, and there was a cointegration in the data that suggests the long-term relationship among the variables. Therefore, the study applied FMOLS and DOLS models to solve the serial correlation and heterogeneity issues and to investigate the long-term relationship among the Green Financial Indicators, Sustainable Development, and Financial Risk.

The study's findings show that Green financial indicators are essential for promoting sustainability development and achieving sustainable development goals and carbon-neutrality targets set by the United Nations. The study's findings show that green growth effectively reduces GHG emissions and promotes renewable energy consumption, which will eventually be helpful in the achievement of carbon neutrality targets and sustainable development goals (SDGs). The study shows that financial risk is negatively correlated individually and significantly impacts GHG in the long run with other variables. At the same time, green growth positively impacts sustainable development. Increasing investment in technological innovation will affect negative with GHG emissions and reduce emissions. Instead of fossil fuel, using renewable energy enhances the environmental quality. This study confirms that renewable energy consumption effect GHG emissions. The study shows financial inclusion significantly and positively impacts GHG emissions and financial risk. That indicates that financial inclusion has a detrimental effect on sustainable development. On the other hand, financial stability positively impacts sustainable development, but financial stability plays a crucial role in promoting renewable use of energy or power. The impact of FR on the GHGs is small, with a coefficient of (0.000259), and it has a negative impact on the coefficient of renewable energy consumption 1.67017.

The findings of the effect reveal that technological innovation has a negative effect on sustainable development and financial risk. If the financial risk increases, the investment in technological advancement decreases. In comparison, the increase in new technology companies installing environmentally friendly technology will mitigate GHG emissions.

Overall, the finding shows that FS helps promote renewable energy consumption. Similarly, Soft infrastructure positively impacts the GHGs and financial risk. The impact of soft infrastructure on the GHGs is a little with a coefficient of (0.678363) and has a positive impact on the financial risk with the coefficient (0.39). The overall finding shows that soft infrastructure helps promote financial risk mitigation. Technological innovation has a significant negative impact on GHG emissions and financial risk, indicating that TI can play an essential role in reducing GHG emissions.

Lastly, this is the first study that investigates financial risk as explanatory GHG green growth renewable energy technological innovation, financial inclusion, and soft infrastructure to know how these economic indicators impact financial risk, which is one of the important components in environmental degradation in connection between economic risk and sustainable development. The study reveals that green growth, renewable energy, and technological innovation negatively correlate with financial stability. At the same time, GHG, FI, and SI have a significantly positive impact that mediates the relationship between the green financial indicator renewable energy consumption and sustainable development. Technological innovation and natural resource rent positively mediate between green financial indicators, renewable energy consumption, and sustainable developments. While technological innovation and natural resource rent negatively mediate between the green financial indicators, Renewable energy consumption, and Sustainable developments.

In summary, this research analyzed how green financial indicators affect long-term prosperity. and financial risk in 111 selected countries. The findings highlight the critical role of green growth, technological innovation, and renewable energy in promoting sustainable development and achieving carbon-neutrality targets and sustainable development goals. Recent research has demonstrated that financial inclusion plays a vital role in promoting sustainable development, positively impacting various aspects. Additionally, soft infrastructure, including technological advancements, has been identified as contributing to positive outcomes. This implies that countries focusing on producing goods and services related to soft infrastructure and technological advancements may inadvertently contribute to higher greenhouse gas (GHG) emissions. Such elevated GHG emissions can significantly threaten environmental quality and sustainability. It is essential to carefully balance the benefits of financial inclusion and technological progress with the need for environmental preservation and mitigation of GHG emissions.

5.2 Recommendations

5.2.1 Recommendations for Policymakers

The findings of this study hold essential recommendations for policy development and implementation. The identified forms of environmental deterioration and associated impacts will likely be prevalent across these countries, highlighting the need for urgent action. Policymakers in these nations can use the study's findings to establish effective policies addressing their specific environmental challenges. One key recommendation is to prioritize the implementation of green growth mechanisms in these countries. Governments can drive economic growth by promoting and facilitating investments in renewable energy and environmentally sustainable projects while addressing environmental concerns with advanced eco-friendly technology. This includes developing policies that encourage financial institutions to support and fund green initiatives and providing incentives and subsidies to attract private investments in renewable energy.

These selected 111 countries should also consider adopting policies to reduce their carbon emissions. The study suggests that implementing CO_2 taxation policies can effectively 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 invers impact of the tax on the economy.

Furthermore, these countries must 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 and fostering collaborations between public and private entities to drive innovation and sustainable practices. Given the diverse economic, social, and environmental contexts of the 111 countries, it is essential to tailor policies to their specific needs and capacities. Policymakers should thoroughly assess 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 toward sustainable development.

Overall, the findings of this study provide valuable insights and recommendations for policymakers in 111 countries, highlighting the importance of green growth, renewable energy 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.

5.2.2 Recommendations for Researchers

In the context of financial stability and Sustainable development, the present analysis is the first step toward a deeper understanding of how, collectively, green financial indicators play a crucial role in promoting sustainable development. This study is the first to investigate financial risk as a dependent variable with GHG, GG, RE, FI, TI, and SI. However, this study provides recommendations that future researchers can address. First, even though this study provides vital insights within the selected countries, it is essential to recognize that the impact of green financial indicators varies considerably across the nations. In addition, future researchers should replicate this study using a diverse group of countries to obtain more accurate and exhaustive results. In addition, future studies can conduct comparative analysis among the different regions and the countries like developing and non-developing countries, developed and non-developed.

Furthermore, 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 growth patterns. Future researchers can also investigate the mediation of governance in the context of green finance and sustainable development. Future studies can also look at the effect of Corruption and tax policies on green growth and renewable energy projects.

5.2.3 Policy Recommendation for the Institution

To manage the problems caused by increasing temperatures and more intense weather events, nations must devote a portion of their budgets to improving the environment. This will encourage the development of environmentally friendly assets on the market and ensure the future well-being of their inhabitants. Policymakers must provide new fiscal and monetary incentive options to encourage firms to move toward a green economy. We can 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 sustainable production facilities. Both public cash and government subsidies are viable options for aiding public-private partnerships working in the sector of renewable energy and technological innovation.

In addition, governmental organizations and authorities should actively support the development of the circular economy and greener energy products. Environmental concerns, geopolitical tensions, and the requirement for increased energy security are pushing forward the shift toward renewable energy sources. Green bonds, climate change projects, and clean energy assets can all be included in an investor or fund manager's portfolio if they adjust to include these types of investments. These investments can be considered environmentally beneficial assets, and they offer the possibility of hedging against various risks, including geopolitical dangers.

The inclusion of offshore wind power in the national carbon emission trading community is something the government should promote. The funding of offshore wind power projects can be made more accessible 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, mainly because of the COVID-19 epidemic, including these enterprises in the national carbon market may help offset some of the costs related to their operations. The availability of green growth technology advancement makes it possible for investors in offshore wind generating projects to take advantage of financing options that are more affordably priced.

In conclusion, institutions should prioritize allocating budgets towards environmental improvement R&D and promoting green assets to ensure a sustainable future. Policymakers must provide fiscal and monetary incentives to encourage businesses and researchers to transition to a green economy and invest in renewable energy. 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.

5.3 Limitations

While this thesis provides valuable insights into the relationship between green growth, technological innovation, renewable energy, sustainable development, and financial stability, it is essential to acknowledge certain limitations. First, the study focused on a specific set of countries, 111, and the findings may differ from GHG higher and lower emitters. For other countries or regions, it is essential to be cautious when making broad assumptions based on the results. Secondly, the data used in this study covers the time from 2004 to 2019, and more recent developments or policy changes might have yet to be fully captured. Future research should consider incorporating more up-to-date data to provide a comprehensive analysis. Despite these limitations, this thesis serves as a valuable contribution to the existing literature and provides a foundation for further research in this field.

References

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Appendix

Variables	Symbols	Definition of Variable	Measurement	Source
Dependent Variable				
Sustainable Development	GHG	Several mechanisms influence the concentrations of greenhouse gases. Others, like vegetation, soil, wetland, and ocean sources and sinks, operate on timescales ranging from hundreds to thousands of years. Carbon dioxide, methane, ozone, and chlorofluorocarbons (CFCs) concentrations in the atmosphere have increased steadily because of human activities, particularly the combustion of fossil fuels since the Industrial Revolution.	"Metric tons per capita"	WDI, 2020
Independent Variables (Focused Variables)				
Renewable Energy	LR	"Renewable energy consumption is the share of renewable energy in total final energy consumption".	"% of total final energy consumptions"	WB, 2020
Financial Risk	FR	Financial risk is the likelihood of suffering financial losses because of business or investment decisions. It incorporates a variety of hazards inherent to financial management, which can result in decreased capital for individuals and businesses alike. These risks encompass a variety of facets, including credit, liquidity, and operational dangers.	Total Debt services (% export of goods & services & primary income)	WDI, 2020
Green Growth Index	GG	GDP, Nitro, CO2, PM2.5, Ind waste, wastewater, Urban Construction, R&D budget, %	Index	WDI 2020 OECD
Technological Innovation	TI	The percentage export of technology over the total technology innovation	Medium technology export %of total Manufactured export	WDI, 2020
Financial Inclusion	FI	The accessibility, availability, of Atm and bank branches per lac use of banking services	Atm and Branches per lac	WDI, 2020
Renewable Energy	RE	The consumption of renewable energy over percentage of total energy	% Renewable Energy Consumption with total energy,	WDI, 2020
Soft Infrastructure	SI	Soft Infrastructure Fixed broadband subscriptions	Soft Infrastructure Fixed broadband subscriptions	WDI, 2020
Independent Variables (Control Variables)				
Industrialization	CVI	"GDP per capita is gross domestic product divided by midyear population".	"Constant 2010 US$"	WB, 2020
Population growth,	CPG	The percentage increase in population annually over the total population.	% annual growth,	WDI
Urbanization	CU	The population preferred living in urban area and occupied area km2 over the total	"% of urban population over total population"	WDI, 2020
Literacy level	CLL	The secondary education enrollment per lac	Secondary education per lac	WDI, 2020

Fixed Effect

Fixed Effects				Number of obs =	1,776	
Group variable: Country				Number of groups =	111	
R-squared:				Obs per group:	min =	16
Within = 0.3441					avg =	16
Between = 0.0856					Overall = 0.0873	

GHG	Coefficient	Std. err.	t	P>t	[95% conf.	interval]
FR	-0.00919	0.005907	-1.55	0.12	-0.02077	0.002401
GG	-6.23752	11.32334	-0.55	0.582	-28.4471	15.97206
TI	0.022319	0.008221	2.71	0.007	0.006194	0.038444
RE	-0.09877	0.008067	-12.25	0	-0.1146	-0.08295
FI	0.073877	0.009807	7.53	0	0.054642	0.093113
SI	0.022195	0.002743	8.09	0	0.016814	0.027576
CVLL	-0.03919	0.021055	-1.86	0.063	-0.08048	0.00211
CPG	-0.0052	0.004858	-1.07	0.284	-0.01473	0.004326
CUG	0.89768	0.086868	10.33	0	0.727298	1.068062
CVI	0.104761	0.024142	4.34	0	0.057409	0.152113
_cons	7.168411	0.345877	20.73	0	6.490009	7.846812
sigma_u	1.561875					
sigma_e	0.111448					
rho	0.994934	(fraction	variance	due	to	u_i)
F test that all	u_i=0:	F(110, 1655) = 1512.95			Prob > F = 0.0000	

Random Effects

Random effects		*GLS regression*				*Number of obs*	*1,776*
Group variable: Country		=				Number of groups	111
R-squared:						Obs per group:	min = 16
Within =	0.3435						avg = 16
Between	0.0964						max = 16
Overall =	0.098						
corr(u_i, X) = 0 (assumed)						Wald chi2(10) =	819.12
						Prob > chi2 =	0.0000
GHG	Coefficient	Std. err.	z	P>z		[95% conf.	interval]
FR	-0.009647	0.0061723	-1.56	0.118		-0.0217	0.00245
GG	-4.888004	11.83626	-0.41	0.680		-28.087	18.3106
TI	0.022064	0.0085752	2.57	0.010		0.00526	0.03887
RE	-0.100741	0.0083918	-12.00	0.000		-0.1172	-0.0843
FI	0.07162	0.0102016	7.02	0.000		0.05163	0.09161
SI	0.025061	0.0028411	8.82	0.000		0.01949	0.03063
CVLL	-0.043289	0.021975	-1.97	0.049		-0.0864	-0.0002
CPG	-0.005943	0.0050766	-1.17	0.242		-0.0159	0.00401
CUG	0.823799	0.0855753	9.63	0.000		0.65607	0.99152
CVI	0.110595	0.0251249	4.40	0.000		0.06135	0.15984
_cons	7.447203	0.3556478	20.94	0.000		6.75015	8.14426
sigma_u	0.984278						
sigma_e	0.111448						
rho	0.987342	(Fraction	of variance due			to u_i)	