NEXUS AMONG CO2 EMISSIONS, TRADE OPENNESS, INCOME INEQUALITY, RENEWABLE ENERGY, NON-RENEWABLE ENERGY, AND ECONOMIC GROWTH: A COMPARATIVE ANALYSIS IN CHINA AND INDIA

By

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Declaration

I hereby declare that all information, documents, analysis, and results contained in this thesis were compiled and presented in accordance with the academic rules and ethical guidelines of the Near East University Institute of Graduate Studies. I also certify that, as required by these rules and conduct, I have properly cited and referenced all non-original information and data used in this study.

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ABSTRACT

This study aims to examine the relationship between CO_2 emissions, trade openness, income inequality, renewable energy, non-renewable energy, economic development, and factors related to CO_2 emissions and income inequality, focusing on India and China. The research utilized annual data from a World Bank indicator of global development from 1971 to 2017. This research applies quantitative techniques, including unit root tests, ARDL bound tests, short-run ARDL and ECM models, estimated long-run coefficients, residual diagnostics tests, and Granger causality tests, to a comparative analysis framework. The analysis shows that the model meets the assumptions of normality, homoscedasticity, and autocorrelation, demonstrating its reliability and validity for both India and China.

The findings reveal a complex network of interdependencies between the variables. ARDL-related experiments confirmed the existence of long-term relationships between variables in both countries. However, renewable energy, income inequality, and population growth are having a negative impact. Except for trade openness and industrialization, which have no significant outcome on CO_2 emissions, similar relationships were observed in China. Similar outcomes were predicted by the long-term estimates. GDP, fossil fuels, and trade openness had positive impacts on carbon emissions in both countries, while renewable energy volatility, income inequality, and population growth had negative impacts. The causality between variables was determined using Granger causality analysis. Results indicate that income inequality is the root cause of carbon emissions in both nations. In China, the relationship between trade openness and carbon emissions was bidirectional, whereas in India it was unidirectional. In addition, causal relationships existed between GDP and other variables in both countries.

Policymakers should prioritize strategies for sustainable development that strike a balance between economic growth, environmental protection, and social justice. Stimulating investment in renewable energy, technological innovation, and energy efficiency measures can play a key role in reducing carbon emissions while boosting economic growth.

KEYWORDS: Carbon emissions, trade openness, income inequality, renewable energy, non-renewable energy, and economic growth.

ÖZ

Bu çalışma, Hindistan ve Çin'e odaklanarak CO2 emisyonları, ticari açıklık, gelir eşitsizliği, yenilenebilir enerji, yenilenemeyen enerji, ekonomik kalkınma ile CO2 emisyonları ve gelir eşitsizliği ile ilgili faktörler arasındaki ilişkiyi incelemeyi amaçlamaktadır. Araştırma, Dünya Bankası'nın 1971'den 2017'ye kadar küresel kalkınma göstergesinden elde edilen yıllık verileri kullanmıştır. Bu araştırma, birim kök testleri, ARDL sınır testleri, kısa vadeli ARDL ve ECM modelleri, tahmini uzun vadeli katsayılar, artık teşhis testleri dahil olmak üzere niceliksel teknikler uygulamaktadır. ve Granger nedensellik testlerini karşılaştırmalı bir analiz çerçevesine dahil edin. Analiz, modelin normallik, eş varyans ve otokorelasyon varsayımlarını karşıladığını ve hem Hindistan hem de Çin için güvenilirliğini ve geçerliliğini ortaya koyduğunu göstermektedir.

Bulgular, değişkenler arasında karmaşık bir karşılıklı bağımlılık ağını ortaya koyuyor. ARDL ile ilgili deneyler, her iki ülkede de değişkenler arasında uzun vadeli ilişkilerin varlığını doğruladı. Ancak yenilenebilir enerji, gelir eşitsizliği ve nüfus artışı olumsuz etki yaratıyor. CO2 emisyonları üzerinde önemli bir sonucu olmayan ticari açıklık ve sanayileşme dışında Çin'de de benzer ilişkiler gözlemlendi. Uzun vadeli tahminlerde de benzer sonuçlar öngörülüyordu. GSYİH, fosil yakıtlar ve ticarete açıklığın her iki ülkede de karbon emisyonları üzerinde olumlu etkileri olurken, yenilenebilir enerji dalgalanması, gelir eşitsizliği ve nüfus artışının olumsuz etkileri oldu. Değişkenler arasındaki nedensellik Granger nedensellik analizi kullanılarak belirlendi. Sonuçlar, her iki ülkede de karbon emisyonlarının temel nedeninin gelir eşitsizliği olduğunu gösteriyor. Çin'de ticari açıklık ile karbon emisyonları arasındaki ilişki iki yönlüyken, Hindistan'da tek yönlüydü. Ayrıca her iki ülkede de GSYH ile diğer değişkenler arasında nedensel ilişkiler mevcuttu.

Politika yapıcılar, ekonomik büyüme, çevre koruma ve sosyal adalet arasında denge kuran sürdürülebilir kalkınma stratejilerine öncelik vermelidir. Yenilenebilir enerjiye, teknolojik inovasyona ve enerji verimliliği önlemlerine yatırımın teşvik edilmesi, ekonomik büyümeyi artırırken karbon emisyonlarının azaltılmasında da önemli bir rol oynayabilir.

ANAHTAR KELİMELER: Karbon emisyonları, ticarete açıklık, gelir eşitsizliği, yenilenebilir enerji, yenilenemeyen enerji ve ekonomik büyüme.

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Abbreviations

ADB: Asian Development Bank

ADF: Augmented Dickey Full

ARDL: Auto regression distribution lag

BRI: Belt and Road Initiative

EKC: Environmental Kuznet Curve

FDI: Foreign Direct Investment

FFE: Fossil Fuel Consumption

GDP: Gross Domestic Product

GHG: Green House Gases

GMM: Generalized Method of Moments

OECD: Organization for Economic Cooperation and Development

PP: Phillips Perrons

REC: Renewable Energy Consumption

UNDP: United Nations Development Programme

WTO: World Trade Organization

CHAPTER 1. INTRODUCTION

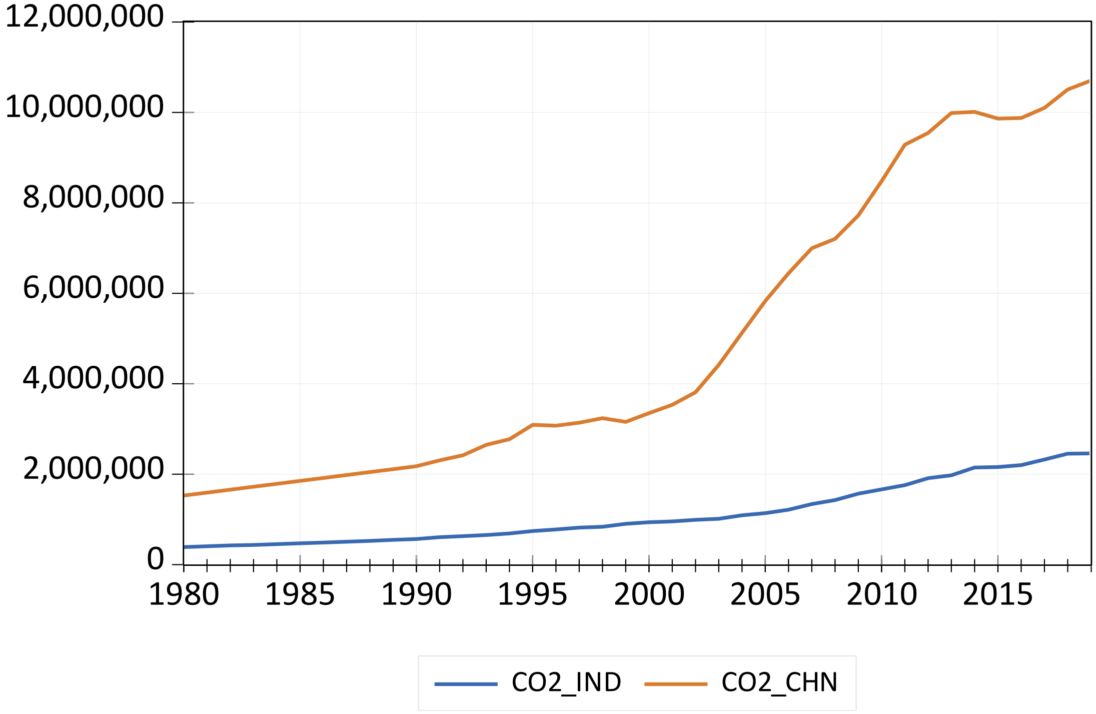
1.1 Background to the study

The issue of global warming has captured the attention of many, emphasizing the significance of addressing the environmental concern that demands prompt action. The origin of CO2 emissions can be traced to non-renewable energy sources such as coal, which were extensively utilized during the Industrial Revolution era. Even today, people engage in various activities like manufacturing processes that contribute significantly to greenhouse gas emissions; these harmful gases result in a heat-retaining effect, thereby causing disruption and increasing temperature, leading to climate alterations worldwide. To combat carbon discharges and reduce potential risks that necessitate joint efforts focused on harnessing renewable resources, it is important to implement sustainable energy-efficient measures by minimizing traditional fuel usage. These actions required not only government authorities; however, public entities should consider limiting reserves while dealing with rising needs demanding quick adoption of green technologies, along with capitalizing on naturally replenishing solar and wind-powered options that provide secure energies, thus lowering GHG releases (Zhang & Wang, 2017). These eco-friendly substitutes effectively decrease reliance upon fossil-fueled systems, reducing expenses and concurrently creating new job opportunities by facing unique challenges related to upfront investment costs closely associated with fluctuating supply patterns and demanding ongoing policy interventions supported via technological advancements."

When a society's distribution of wealth among individuals or households is deemed unfair, income inequality arises. This has become an increasingly widespread issue in numerous countries worldwide because the gap between rich and poor is widening (Reisch et al., 2013). To quantify levels of income disparity, experts employ a tool called the Gini coefficient, which assigns numerical values ranging from zero for absolute equality up to one for total inequality. Unlike other approaches focused on specific wage brackets, this measurement assesses disparities throughout all layers of society while also providing policymakers with valuable insights into their economic policies' effectiveness at dealing with such problems. Addressing concerns about rising wage gaps remains crucial because both imbalances in earnings and discrepancies highlighted by the Gini index continue to be highly contested issues impeding progress toward establishing more equitable models globally. Economic growth refers specifically to sustained increases over time in production volume generated by nations' goods and services, alongside critical factors influencing it, including human capital development rates. Well-infrastructure improvements resulting from government initiatives aimed toward sustainable policy-making practices designed explicitly to meet societal preferences vis-à-vis environmental sustainability goals without compromising future generations' prospects, dignity, or healthfulness Achieving social and environmental outcomes requires evaluating the impacts arising from technology and the market. (Edenhofer et al., 2013). Advancements considering natural resource use patterns, carbon emissions management, governance arrangements, and stakeholder interests along productive supply chain value chains encompassing multiple sectors necessitate transparency and accountability-based decision-making processes yielding social and ecological benefits beyond purely financial gains, irrespective of regional or national considerations, ensuring inclusivity and sustainability trajectories are accomplished.

China and India are the two giant economies in the Asia region. Even though each nation's population exceeds a billion people, tremendous effort has been made to provide their citizens with the best possible life. The Indian government faces several obstacles in its efforts to keep up with the country's rising energy demand, including the need to secure affordable energy supplies and the lure of investment for upstream projects and transmission infrastructure. Increased energy security, infrastructure development, and market liberalization remain central to ongoing energy reforms. China's economy is expanding swiftly, and it is the world's largest energy purchaser and producer. Energy demand is anticipated to rise. In 2021, India will be the third-largest energy consumer in the world, behind China and the United States, and population growth and modernization are expected to increase energy demand even further. The transitional growth of their economies in terms of reduced trade and investment barriers, accelerated technology transfer, and highly mobile regional capital and labor is widely acknowledged (Jayanthakumaran et al., 2012). The COVID-19 pandemic outbreak caused India's GDP to grow at a negative rate in 2020. In 2021, the economy returned to normal activity levels, and GDP increased. The pandemic has reduced China's industrial and economic activity and energy consumption, and the resurgence of COVID-19 cases and the country's regional quarantine policies are likely to make it more challenging for the government to achieve its 2022 GDP growth target.

Figure 1 CO2 Emission of India and China



China is the world leader in renewable power generation, well ahead of the US in second place. The country's renewable energy division is developing at a faster pace than fossil fuel and nuclear power generation capacity combined, making it the largest contributor to the increase in global renewable energy capacity. It is estimated that by 2060, non-fossil fuels will make up 80% of the country's total energy mix. Despite owning the world's largest installed hydro, solar, and wind capacity, the country's energy demand is so high that coal-fired power plants will account for 26% of its electricity generation in 2019. By 2021, renewable energy will account for 40% of China's total installed power and 29.4% of total power generation, and by 2025, the share is expected to reach 36%. Renewable energy faces major logistical challenges in China. Grid connections between renewable energy power plants and the power grid must be addressed. In recent years, renewable energy planners have rushed to obtain land permits for the time-consuming grid construction and uncoordinated construction of wind farms, solar panels, and other power plants.

Permitting high-voltage transmission lines and other grid connections took as long as obtaining permits and starting construction of the power plant, and as a result, a lot of time. A significant amount of renewable energy is produced during this period, but it is not connected to the grid, so it will be wasted. India is the third-largest consumer of electricity in the world and a producer of renewable energy; by 2022, 40 percent of newly installed energy capacity is projected to originate from renewable sources. The nation pledged in 2016 to generate 50 percent of its electricity from non-fossil fuel sources by 2030. Solar, wind, and hydropower are low-cost energy sources in India. To cover peak demand, coal-fired power generation, which depends on imports from overseas, is shifting from "base load that must be operated without fail" to load-following power generation. Renewable hydropower peak capacity is already meeting some of India's daily peak demand. Compared to new coal and gas power plants, solar and wind power are already cost-competitive in India with four-hour storage systems. China is her biggest CO2 emitter, accounting for 27% of global emissions.

Emissions are mainly caused by fossil fuels, which are mainly used to burn coal to generate energy. Due to its high carbon content, coal accounts for almost half of all energy production. China is also one of the largest importers of oil and a major contributor to the country's carbon footprint from vehicle use. In the future, the company plans to generate more electricity from nuclear, renewables, and natural gas, reduce its dependence on coal, and reduce overall pollution in big cities. India is now the world's third-largest CO2 emitter after China and the United States. Given the country's population, these figures in 2019 are highly uncertain, but a comprehensive greenhouse gas inventory is within reach. Its annual emissions per person are lower than the global average, with the UNDP projecting that they will be between 3 and 4 tons by 2030. Reduced greenhouse gas emissions and air pollution entitle it to health benefits worth four to five times the cost, making it the world's most cost-effective. India generated 39.8% of its electricity from renewable sources and 60.2% from fossil fuels as of September 2021, with coal accounting for 51%. Oil, natural gas, and other liquids account for the rest of energy consumption. The country aims to increase its natural gas market share from 6% to 15% by 2030 to reduce air pollution and use cleaner-burning fuels. After decades of economic stagnation and recession under communist rule, China liberalized its economy and established diplomatic and trade ties with the United States in 1979, opening it up to international trade. It is the world's second-largest economy after the

United States in terms of GDP and the largest in the world, surpassing the United States in purchasing power parity (PPP). It is projected to be the largest economy in the world for the next 40 years. Since 2000, the Indian economy has grown the fastest in the world. It is the fifth-largest economy in the world by nominal GDP. In 2019, the Indian economy grew at an annual rate of 5%. This expansion was primarily driven by high demand for domestic goods and services and strong industrial activity. The country was once known for its tea and cotton production, but it now has a diverse economy, with the service sector driving most of the activities and growth. India is now considered a "global player" in international economics. The response to the COVID-19 pandemic has had a significant impact on the Indian economy in 2020-2021. The GDP of India for the second quarter of 2020 was close. This rapid growth is the result of increased energy consumption and air pollution. A significant reduction in greenhouse gases will necessitate a significant shift to more sustainable energy sources in the fields of energy and the environment (Qi, Zhang, and Karplus 2014). For the past few decades, income inequality in these nations has been progressively rising. India's Gini coefficient is currently about 0.35, while China's is about 0.38 as of 2021. Even though China scored slightly higher, inequality there has significantly decreased since the late 1990s. In contrast, India has seen a rise in value since the early 2000s. Several variables, including economic policies, social assistance programs, and the educational system, might be blamed for these inequalities. To foster social cohesiveness and stability, both nations must concentrate on lowering income inequality.

1.2 Problem Statement

Balancing economic development with environmental sustainability is a significant challenge the world is currently experiencing. Countries are searching for strategies to lessen their carbon footprint while preserving economic growth, as the problem of CO2 emissions has grown to be a worldwide concern. The objective of this study is to identify possible policy interventions to reduce carbon emissions and achieve sustainable development. This study examines the relationship between trade, income inequality, renewable energy, non-renewable energy, economic growth, and carbon emissions in China and India to reduce carbon emissions and achieve sustainable development, as well as to identify viable policy interventions. Economic growth has been found to be significantly impacted by trade openness, which is the extent to which a nation engages in international trade. However, since commerce sometimes entails the delivery of goods and services over large distances, which calls for the use of fossil fuels, increased trade may also result in higher levels of CO_2 emissions. Furthermore, if the advantages of trade are not equally dispersed, trade openness may make income inequality worse. Renewable energy sources, like solar and wind energy, are seen to have promises for lowering CO_2 emissions and preventing climate change. The adoption of renewable energy is, however, frequently constrained by high costs and a lack of infrastructure. Oil and other non-renewable energy sources, including coal, continue to be the primary energy sources in many nations and are a major source of CO_2 emissions.

Among the biggest and fastest-growing economies in the world is China, followed by India. In terms of CO_2 emissions, India ranks third in the world, with China currently leading. Coal continues to be China's main energy source despite its efforts to switch to cleaner energy sources. India continues to utilize coal as its primary fuel and wants to build more coal-fired power facilities. The excessive reliance on coal is one of the key factors contributing to these countries' rising CO_2 emissions. Their rapidly expanding industrialization and increasing populations have also made a sizable dent in the rise in greenhouse gas emissions. Nonetheless, both nations have begun to take action to address the problem of carbon emissions. China has committed to investing in renewable energy sources, including wind and solar electricity, whereas India has pledged to use 40% more sustainable energy than its current energy capacity by 2030. To properly address this issue in both countries, there is still more work to be done; however, the effectiveness of these policies remains uncertain.

The link between carbon emissions and many factors, including energy sources, income disparity, trade openness, and economic development in China and India, has been studied in the past. When it comes to thorough analyses of economic growth and their interaction, there are gaps in the research. There is a need for research into the intricate relationships between these elements and how they affect CO_2 emissions in China and India. To discuss these complex relationships and advance sustainable development in both countries, there is also a need for research that identifies relevant policy interventions that can be implemented. By carefully examining the connections between carbon emissions, energy sources, economic inequality, trade openness, and environmental deterioration, this study tries to bridge research gaps. The present study investigates the link between carbon emissions, energy sources, income inequality, trade openness, and economic development in China and India to close this knowledge gap. In addition, possible political interventions to achieve long-term development are also identified.

While previous studies have separately explored factors influencing carbon emissions and income inequality in China and India, a comprehensive comparison of these variables in the two countries is needed. Furthermore, previous research has not fully investigated the links between the various factors that influence CO_2 emissions and wealth disparity in both countries. As a result, more research is needed to gain a thorough understanding of the main factors influencing CO_2 emissions and wealth inequality in China and India, as well as how these factors differ between the two countries. The research investigates how the various variables interact with one another and how this affects things like CO_2 emissions and economic inequality. Such research could help decision-makers devise effective strategies.

Further evidence of the need for additional study in various situations and areas comes from earlier studies conducted in other nations, which produced inconsistent results. Although there are studies that look at the connection between economic disparity and carbon emissions, there aren't many that concentrate on the situations in China and India. Therefore, it is necessary to do research that focuses on the connection between economic disparity and carbon emissions in these two nations. The study examines the various influences on carbon emissions and economic disparity in both nations, as well as how these influences interact. The study also considers the possible policy ramifications of the connection between income inequality and carbon emissions and provides advice for developing effective programs.

1.3 Research Question

The main research questions include:

1. What is the relationship that exists between CO_2 emissions, energy sources, income inequality, trade openness, and economic growth in China and India?
2. What are the primary factors influencing CO_2 emissions and income inequality in China and India, and how are these factors differ in the two nations?
3. How does income inequality affect carbon emissions in China and India?

1.4 Objective of the Research

The main goals or objectives of the studies are:

1. To compare the connection between CO_2 emissions, energy sources, income inequality, trade openness, and economic growth in China and India
2. To investigate the impact of income inequality on CO_2 emissions in China and India,
3. To identify the factors that contribute to income inequality and carbon emission in these two countries.

1.5 Significance/Contribution of the Study

The study compares trade openness, carbon emissions, income inequality, renewable and non-renewable energy, as well as economic growth between China and India. Exploring the variables in these two major emerging markets provides insight into different market dynamics and sustainability challenges. The study enhances our understanding of the link between trade openness and carbon emissions and highlights the importance of environmental regulation and technological progress. In addition, the relationship between income inequality and economic growth is explored, as is the impact of income distribution on development pathways. This study explores the impact of renewable and non-renewable energy sources on economic growth and emissions, highlighting the progress and challenges of the transition to clean energy. Findings contribute to evidence-based policies for sustainable growth, reduced inequality, and increased renewable energy adoption. The comparative analysis deepens understanding of the nexus and its implications for global sustainability challenges. Rigorous statistical techniques ensure reliable results, while the focus on China and India informs policymakers on trade, the environment, income redistribution, and renewable energy decisions. Moreover, this research provides a foundation for future studies to expand the comparative analysis to other countries or regions, further enriching knowledge on the nexus among these variables.

1.6 Hypothesis

H0: CO_2 emissions, renewable energy, fossil fuel energy, income inequality, trade openness, and economic growth do not have significant relationship in China and India.

H1 CO_2 emissions, renewable energy, fossil fuel energy, income inequality, trade openness, and economic growth have significant relationship in China and India.

H0: Income inequality does not have impact on C02 emission.

H1: Income inequality has impact on C02 emission.

1.7 Organization of the Study

The investigation consists of six distinct sections. The previous introduction describes the study's context, problem statement, research questions, study objectives, significance, and variables' hypothesis. The second section examines empirically relevant literature pertinent to the study. Section three of the conceptual framework included a discussion of the related theories and theoretical framework. The fourth chapter describes and illustrates the data as well as the methods to be used. Chapter five is regarded as the study's heart because it expresses important findings and holds pertinent discussions in this topic. The final section contains an overall assessment of the work, flaws, and potential recommendations.

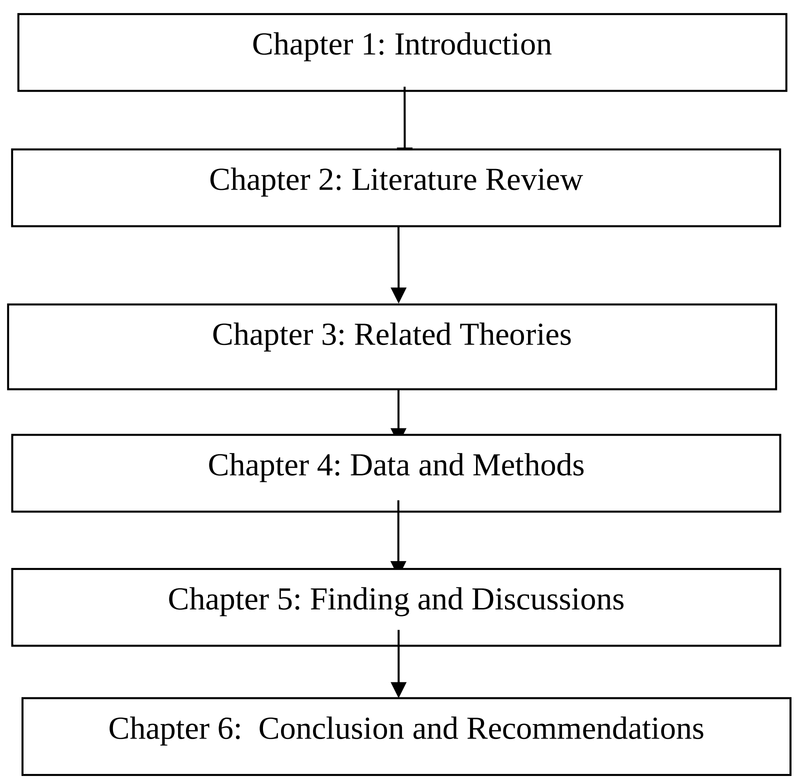


Figure 2: Organization of the Study

CHAPTER 2. LITERATURE REVIEW

In recent years, scientists and policymakers around the world have become increasingly interested in the connection between economic growth, trade openness, energy use, CO_2 emissions, income inequality, and renewable energy. Due to their huge populations and rapid economic growth, Asia's two superpowers, China and India, have been the focus of much research in this area. Both have achieved rapid economic growth in recent years and are important players in the global economy. However, this development is escorted by a rise in CO_2 emissions, which contributes to weather change and its adverse effects. Research in this area is therefore extremely important, especially in the context of these two Asian economic powers. Understanding the connection between these variables and CO_2 emissions will help policymakers find appropriate measures to achieve economic growth while reducing adverse environmental impacts.

Through comparative studies of China and India, this literature review seeks to provide a comprehensive understanding of the relationship between trade liberalization, carbon emissions, income inequality, renewable and non-renewable energy, and economic growth. This review will concentrate on the following three key research questions:

1. What is the relationship between carbon emissions, energy sources, income inequality, trade openness, and economic growth in China and India?
2. What are the key factors affecting carbon emissions and income inequality in China and India, and how do these factors differ between the two countries?
3. How will income inequality affect carbon emissions in China and India?

To answer these questions, we consider relevant literature and research on the subject, including peer-reviewed journal articles, reports, and other relevant publications. This review provides a thorough overview of the latest research on this important topic by evaluating and summarizing the findings of these studies.

2.1 Relationships between carbon emissions, energy sources, income inequality, trade openness, and economic growth in China and India

The interplay between these variables on this subject has been the subject of countless studies by many researchers. A study by Alam et al. (2011) examined the link between energy consumption, CO_2 emissions, and income in India. Using dynamic modeling techniques and innovative accounting methods, the study found no convincing evidence of a causal relationship between energy consumption and income in either direction. However, the study found evidence of a two-way causal relationship between energy consumption and CO_2 emissions in the long run. This implies that India has the potential to promote energy efficiency and savings without compromising its economic growth or hindering its ability to reduce carbon emissions. Similarly, Alam et al. (2016) studied the effects of income, energy consumption, and population growth on CO_2 emissions in India, Indonesia, China, and Brazil from 1970 to 2012. The results obtained through the autoregressive distributed lag (ARDL)-related test indicate that CO_2 emissions increase significantly with increasing income and energy consumption in all four countries. The relationship between CO_2 emissions and population growth was statistically significant in India and Brazil, but not in China or Indonesia. According to this study, the Environmental Kuznets Curve (EKC) hypothesis holds true for Brazil, China, and Indonesia, but not for India. The results suggest that India should take proactive steps to reduce carbon emissions, while the other three should avoid actions that could hamper their economic growth.

Considering that China and India are among the leading contributors to CO_2 pollution (Jiao et al., 2022), this analysis focused on understanding the characteristics of CO_2 emissions and the motivating factors behind them. The study collected CO_2 emissions inventories spanning from 1990 to 2017 and utilized the Tapio model and exponential decomposition analysis to explore the influence of socioeconomic factors on CO_2 emissions. Over the period from 1990 to 2017, both countries experienced a compound annual growth rate (CAGR) of 5% in CO_2 emissions. While China has maintained a relatively small gap between economic growth and emissions since 2012, India's emissions have steadily increased. Population growth and economic expansion emerged as the primary drivers of CO_2 emissions in both countries. However, in India, the growth in emissions has slowed since 2008 due to the impact of energy intensity. To understand the variables that influence national emissions, Jayanthakumaran et al. (2012) used statistical analysis techniques to study China and India. According to the study, per capita income, structural change, and energy consumption are affecting China's carbon emissions. But India's huge informal sector and numerous low-energy microenterprises are preventing similar connections. A global consensus has been reached on how climate change will affect these two countries.

The impact of income and expenditure distributions on welfare indices in China and India has been assessed by Gradín et al. (2019). Our analysis shows that both types of inequality are equal in China, while income is concentrated in spending in India, especially among the top tiers of the distribution. Expenditure inequality is more common than income inequality in China's urban areas. In China, we find a strong correlation between individual rankings and happiness distributions. China's income inequality is much lower than India's due to demographic differences and a conditional income distribution based mainly on the household head's education level, but spending inequality is greater in China. The study argues that it is possible to compare happiness across countries using a hybrid happiness measure that incorporates income and expenditure.

Recent research by Rai et al. (2019) utilized time-series data spanning 1978 to 2014 to compare a variety of factors in India, including carbon emissions, energy consumption, foreign direct investment, GDP, and trade openness. The goal is to examine the relationship between these variables. The results show a long-run correlation between the variables and provide convincing evidence of a one-way causality between energy consumption, foreign direct investment, GDP, and the openness of the economy to energy consumption. Moreover, the study demonstrates that the integration of new and energy-efficient manufacturing technologies can contribute to reducing carbon emissions without impeding the rapid economic development made possible by foreign direct investment and openness. Using log-transformed annual data from 1970 to 2014, Shahani & Bansal (2021) examined the co-integration relationship between economic growth, energy, and the environment in China and India. This study uses an autoregressive distributed lag 'F' boundary test with a single structural break as methodology. The results show that all variables exhibit an energy-integration relationship, except for CO_2, which is used as the dependent variable for China. There was a large negative error-correction model term in all situations, except for China's CO_2. In India, CO_2 emissions are balancing out at the fastest pace of 16% annually. India stopped emitting CO_2 in 1996, according to the Chow Breakpoint Test. To provide policy implications for both economies, Sudan (2022) compared trade openness and economic growth. The two countries' export shares have increased since 1991 but fell in 2008 due to the global recession, according to the report. Currently, India's most important trading partner is China, but as the bilateral trade gap widens, it is becoming difficult to maintain trade between the two countries. India needs to strengthen mutual agreements on tariff values and norms, focus on exporting technology-intensive goods to China, and remove trade barriers to address this issue. Both countries are very open-minded, but growth has slowed slightly in both countries recently, and free trade and persistent reforms are needed to achieve sustainable growth rates.

In addition, Sorge & Neumann (2017) analyzed the relationship between trade openness, GDP, and energy consumption from 1971 to 2013 for 70 WTO countries. This analysis provides supporting evidence for the Environmental Kuznets Curve (EKC) for all earnings tables. The results indicate that the relationship between energy consumption and economic development in high-income countries is different from that in low- and middle-income countries. There is evidence that opening trade increases energy use and carbon emissions at all income levels. GDP is what drives CO2 emissions. In any case, the general effect of economic development may constrain carbon outflows across all income groups in the future. Baloch et al. (2020) examined the relationship between carbon emissions, poverty, and income inequality in 40 sub-Saharan African countries from 2010 to 2016. Addressing economic inequality and poverty in target countries is critical to achieving the Sustainable Development Goals. Hailemariam et al. (2020) investigated the relationship between carbon emissions and income inequality in OECD countries. To capture some features of income distribution, the researchers used a new dataset on top income inequality and the Gini coefficient. The data show that an increase in the Gini Inequality Index is associated with a decrease in carbon emissions, and an increase in inequality among high-income groups is associated with an increase in carbon emissions. According to the environmental Kuznets curve, the study also shows a non-linear relationship between economic growth and carbon emissions. The results show that measures to reduce inequality among high-income earners can help reduce carbon emissions and improve environmental conditions.

Chen et al. (2019) used the autoregressive distribution lag (ARDL) limit test method to analyze China's per capita carbon dioxide (CO2) emissions, GDP, renewable and non-renewable energy production, and external A study was conducted to estimate trade relations. In addition, we used the Granger causality approach of the Vector Error Correction Model (VECM). The results show long-term relationships between these variables, and no environmental Kuznets curve (EKC) for CO2 emissions exists for China when considering the effects of economic development, non-renewable energy production, and international trade. It has been suggested. However, the inclusion of renewable energy generation variables supported the hypothesis of an inverted U-shaped EKC in the long run. The study also found that both GDP and non-renewable energy contribute to carbon emissions, while renewable energy and international trade have opposite effects. A short-term Granger causality test showed mutual causality between foreign trade, carbon emissions, and non-renewable and renewable energy. The study concludes with recommendations for his CO2 reduction strategy for China. Another study conducted by Wang et al. (2011) investigated the causal relationship between CO2 emissions, energy consumption, and real economic activity in 28 provinces of China from 1995 to 2007. The results showed a reciprocal causal relationship between CO2 emissions and energy consumption and between energy consumption and economic growth. Energy consumption and economic growth were identified as long-term causes of CO2 emissions, and CO2 emissions and economic growth were considered long-term causes of energy consumption. The analysis suggested that China's carbon emissions won't decline in the long run, and efforts to cut emissions could hamper the country's economic growth.

Li and Li (2011) analyzed data from 1965 to 2006 and used the Granger causality test to examine the relationship between coal consumption and GDP in China and India. The results showed a one-way causal relationship between GDP and coal consumption in China, while a bidirectional causal relationship between coal consumption and GDP was shown in India. As a result, the study concluded that the development of advanced green technologies is critical to achieving sustainable growth and minimizing carbon emissions in both countries. (Shahani & Raghuvansi, 2020) explored the relationship between economic growth and CO2 emissions in India and China and the applicability of the Environmental Kuznets Curve (EKC) theory from 1960 to 2014. The results indicated that India exhibited high GDP and CO2 emissions, whereas this pattern did not hold true for China. Furthermore, the study identified a unidirectional causal connection between India's GDP and CO2 emissions. We found that, in cubic form, the EKC model can predict China but not India. Diagnostic testing confirmed that both variables were stable and that serial correlations were eliminated. According to the results, India can take energy efficiency and energy conservation measures that do not hinder economic growth and reduce carbon emissions. They used a spatial panel model (You et al., 2020) to explore the links between carbon emissions, democracy, and economic inequality in the 41 Belt and Road Initiative countries. This study supports the Kuznets curve theory and shows positive regional spillovers on CO2 emissions. Research suggests that democracy also strengthens the nonlinear relationship between wealth inequality and CO_2 emissions. According to these findings, countries with high levels of inequality and weak democratic processes are more likely to experience increased pollution levels. The research results stand up to various tests.

2.2 What are the key factors affecting carbon emissions and income inequality in China and India?

In addition, the paper examines the factors that influence carbon emissions and income inequality, as well as how these factors vary between the two countries. (Wang & Zhou, 2018) used the Theil index and exponential decomposition analysis techniques to study global emissions inequality based on per capita consumption. The study concludes that China and India are the primary contributors to emissions inequality on a global scale. Global inequality has gradually narrowed over this period, mainly due to a narrowing difference in per capita consumption levels between countries. However, widening disparities in consumption-related emissions intensity hamper efforts to reduce inequalities. The paper also compares emissions inequality between production-based and consumption-based principles, showing how the latter largely masks differences in the distribution of global CO_2 emissions due to production outsourcing. The trends and underlying causes of carbon emissions in the two countries were compared by the same authors (Wang & Zhou, 2020). Carbon emissions in both countries increased from 2000 to 2014, but on different trajectories. Following the 2008 financial crisis, China experienced a slowdown in its economic growth, while India's carbon emissions increased due to a rising reliance on carbon-intensive energy sources. According to the report, China should focus on modernizing its industries and improving its manufacturing structure, whereas India has the potential to drive the transition to cleaner energy and enhance energy efficiency. The report also suggests that strengthening cooperation and communication with developed countries, leveraging their advanced technology and experience, could contribute to further progress in combating climate change in both nations.

Zhou and Liu (2016) conducted a study using balanced regional panel data from 1990 to 2012 to analyze the impact of population and wealth changes on China's energy-related CO_2 emissions at the national and regional levels. The study concluded that rising incomes, not demographic changes, were the main reason for China's rising carbon emissions. Except for western China, urbanization is known to increase energy use and emissions. Changes in age structure had little impact on energy use but led to increased national emissions, especially in eastern China. This study explores the need to transform traditional economic growth models, manage the pace of urbanization, improve energy efficiency, and modernize the industrial structure to reduce the environmental impact of human activities in China. (Knight et al., 2017) focused on the top 10% wealth share from 2000 to 2010 and compared domestic wealth inequality and consumption-related carbon emissions in 26 high-income countries. The variables consistently exhibited positive and generally stable relationships over time.

In the context of reducing CO2 emissions from residential buildings, Yeo et al. (2015) utilized the Log-Mean Divisa Index (LMDI) methodology to identify and rank the primary factors contributing to carbon footprints in both China and India's housing sectors. The study revealed that energy intensity had a critical effect on diminishing carbon dioxide emissions within the private sector, while the increase in per capita income was a key driver of emissions growth. Investments in energy efficiency, technological advancements, and the implementation of energy regulations were also found to be effective in reducing CO2 emissions. The data indicated that changes in population and energy consumption patterns contributed to the increase in CO2 emissions. (Saidi & Mbarek, 2017) used time series data from 1990 to 2013 to investigate the impact of financial development, prosperity, trade openness, and urbanization on carbon emissions in emerging economies. The results indicated a negative correlation between economic growth and carbon emissions but a positive correlation between income and carbon emissions. The analysis, however, did not provide support for the environmental Kuznets curve hypothesis. In addition, it was discovered that urbanization reduces carbon emissions, highlighting the need for policymakers and urban planners to manage the accelerated urbanization of cities.

Padilla & Duro (2013) investigated the causes and trends of inequality in carbon emissions per capita in the European Union from 1990 to 2009. Theil's inequality index, which is classified into different Kayas, was used in this study. A variable is assigned. The results show that inequality decreased, mainly due to the decreased inequality between groups and the smaller role of energy intensity. GDP per capita has been identified as the most important predictor, while the carbonization index has been identified as the most important factor explaining inequality between groups of countries. The report makes policy recommendations based on the findings. Using the 1980–2006 panel data on different country groups, Guo (2013) investigated the link between income distribution, per capita income, and CO2 emissions. The results demonstrated an inverse U-shaped association between CO2 emissions and per capita income across all nations in the sample, as well as within the high-income categories. Income inequality had a favorable impact on the total income elasticity of carbon emissions but a negative effect on average carbon emissions, according to the findings. The detrimental effect of income disparity on average CO2 emissions became less noticeable as per capita income climbed. Fan et al. (2020) assessed the geographic disparities in carbon dioxide (CO2) emissions in China, and the contribution of government investment to emissions reductions was also investigated. This study uses the Divisa index and the log-mean decomposition method to explore the causes of emissions inequality and the changes in China's carbon emissions inequality from 2007 to 2015. Data show that regional emission inequality is mainly caused by differences in economic growth, population distribution, energy structure, and government spending, with spending structure being the most important factor. The results provide suggestions on how the Chinese government should set carbon emission reduction targets and implement them through various emission reduction strategies.

Jorgenson et al. (2016) examined the relationship between economic inequality within a nation and carbon emissions from consumption in 67 countries from 1991 to 2008. The findings reveal that the connection between emissions and inequality fluctuates over time and among nations, depending on their macroeconomic situation. In high-income countries, there has been a shift from a negative to a positive correlation, indicating that increasing income inequality in these nations has led to higher carbon emissions in recent years. Conversely, in middle-income countries, this association is unfavorable and worsens over the duration of the study. Throughout the period from 1991 to 2008, no significant relationship was observed between domestic income disparity and carbon emissions in low-income nations. A study by Ohlan (2015) examined the impact of India's population density, energy consumption, economic growth, and trade opening on carbon dioxide (CO2) emissions from 1970 to 2013. In our analysis, we used a vector error correction model to identify the following causal relationships: Variables were used to assess the presence of long-term associations through cointegration using the autoregressive variance lag limit test technique. The data showed statistically significant positive correlations between CO2 emissions and short- and long-term economic development, energy consumption, and population density. Population density was found to have the most substantial influence on changes in India's CO2 emissions. The study also highlighted the potential benefits of implementing a deliberate population stabilization plan in India to reduce carbon emissions while ensuring sustained long-term economic growth. The results support the need for continuous legislative efforts to promote alternative energy sources and the adoption of greener and cleaner technologies, aiming to decrease carbon emissions and energy consumption.

2.3 How does income inequality affect carbon emissions in China and India?

The final research question explores the relationship between income inequality and carbon emissions in China and India. Padilla & Serrano (2006) explored differences in CO_2 emissions between nations and how they relate to wealth inequality from 1971 to 1999. The analysis reveals a significant reduction in wealth inequality among nations, but it has resulted in an unequal distribution of emissions. Whereas overall emissions inequality is decreasing at a faster pace, the disparity in emissions across countries based on income levels remains pronounced. The study emphasizes that the primary factor contributing to the variation in CO_2 emissions is the disparity between groups with diverse per capita income levels, rather than inequality within groups with similar income levels.

In a study by Duro and Padilla (2006), strategies for mitigating global inequality in per capita CO_2 emissions were outlined using the Kaya factor and its two interaction terms: inequality within groups and between groups. The examination of these elements revealed that inequalities in per capita income levels had a relatively minor impact on the authors' conclusions regarding international disparities in per capita CO_2 emissions in comparison to variations in energy carbon intensity. Furthermore, income inequality predominantly influenced the within-group component of inequality. On the other hand, between-group constituents showed a slight increase throughout the analysis period. Ravallion et al. (2000) found a link between income inequality and CO_2 emissions, highlighting its impact on global warming. The study found that lower carbon emissions led to greater inequality within and between countries, even at the same average income level. Increased emissions are typically a result of economic growth, which creates conflicts between social justice, climate change mitigation, and economic development. Reducing inequality, however, can help balance these competing priorities. Combining growth and equity, especially through pro-poor growth policies, improves long-term carbon outcomes.

In a study conducted by Ghazouani and Beldi (2021), the connection between income inequality and carbon emissions in seven Asian countries was examined from 1971 to 2014, employing a nonparametric panel estimation approach. The results demonstrate a striking non-linear relationship between income inequality and per capita carbon footprint. Furthermore, the study notes consistent associations between income inequality and environmental degradation over most of the time periods analyzed. From 1988 to 1997, there was a good correlation between the two variables. Research suggests that there is a "justice and pollution dilemma" where redistribution of wealth can cause pollution. The results of this study have potential implications for the implementation of policies aimed at promoting redistribution in specific Asian countries.

Chen et al. (2020) conducted a study utilizing the extended environmental Kuznets curve approach to explore the correlation between income disparity and carbon emissions in G20 nations. The results suggest that income distribution plays an important role in the impact on carbon emissions and that per capita emissions decrease in emerging economies when income distribution is more equitable. However, in most developed countries, income inequality has a minimal impact on emissions. Furthermore, this study confirmed the existence of the environmental phenomenon of the Kuznets curve in the context of the G20. The report highlights the need for the G20 to move towards sustainable development and the importance of tackling economic inequalities in emerging economies.

Jorgenson et al. (2017) investigated the relationship between income disparity and carbon emissions in US states from 1997 to 2012. The data indicate that, although the Gini coefficient has no effect on emissions, there is a link between a rise in the income share of the top 10% and an increase in emissions. These results indicate that the behavior of high-net-worth individuals (HNWIs) has a significant influence on both the economy and the environment. However, the marginal emissions trend method suggests that increased energy use leads to a more equitable income distribution, contradicting the lack of correlation between the Gini coefficient and emissions.

Kusumawardani & Dewi (2020) investigated the influence of income disparity on carbon emissions in Indonesia from 1975 to 2017 using the autoregressive dispersion lag (ARDL) approach. The findings show that income inequality has a negative influence on carbon emissions, with the magnitude of the impact varying with GDP per capita. The analysis also demonstrates an inverted U-shaped link between GDPs per capita in Indonesia and CO2 emissions, demonstrating the existence of the Environmental Kuznets Curve (EKC). Furthermore, urbanization and reliance have a detrimental influence on CO_2 emissions. The study recommends that policies aiming to promote economic growth and reduce carbon emissions should consider socioeconomic equity.

Huang & Duan (2020) investigated the nonlinear threshold effects of globalization, income inequality, and economic development on global carbon emissions and income inequality. From 1991 to 2015, the authors used a dynamic panel threshold model with cross-sectional-dependent and balanced panel data from 92 countries. This result suggests that there may be nonlinear threshold effects and asymmetric outcomes in the negative association between carbon emissions and income inequality. Income inequality can contribute to increased carbon emissions, but reducing income inequality and boosting economic development can have similar positive effects. Stakeholders are encouraged to support the trend of globalization while carefully weighing the trade-offs between reducing economic inequalities and reducing carbon emissions.

(Liobikienė, 2020) offered a modified strategy to investigate the influence of income inequality on carbon emissions from production and consumption. The author suggested separating production-based emissions from consumption-based emissions and considering the influence of environmental limits, leakage, and the environmental Kuznets curve. To determine the influence of income disparity on consumption-based emissions, two methodologies were proposed: changes in working hours and individual economic decisions of family members. This research sheds new light on the topic, demonstrating the many implications of economic disparity for carbon emissions.

Yang et al. (2020) examined the impacts of income inequality and fiscal insecurity on carbon emissions, as well as the moderating effects of fiscal insecurity. The research used panel data from 47 developing nations covering the years 1980 to 2016. According to the findings, wealth disparity and industrialization reduce environmental deterioration, but fossil fuels, trade openness, and economic development cause it. There is no clear link between financial instability and environmental quality, but pollution can be exacerbated when combined with inequality. Moreover, there is a corresponding causal relationship between CO_2 emissions and interacting variables such as trade openness, industrialization, economic development, income inequality, and financial instability.

Wolde-Rufael & Idowu (2017) examined the association between environmental degradation and income inequality in China and India. The study utilized marginal test techniques for cointegration and variance decomposition analysis. The results show a long-term but statistically non-significant association between income inequality and carbon emissions in both countries. Income inequality can improve environmental quality in China, but not in India, where income and energy use are key determinants of carbon emissions.

Liu et al. (2019) used Global Moran's Gini coefficient to investigate the impact of income inequality on China's carbon emissions. The study found that an increase in income leads to an increase in carbon dioxide emissions, following an inverted U-shaped pattern that supports the environmental Kuznets curve theory. The study also highlighted that rising economic inequality, and an unequal distribution of income are likely to contribute to deteriorating environmental quality and increased carbon emissions. The paper suggests that a fair distribution of income could China's efforts to reduce carbon emissions.

Bhattacharya (2020) investigated the link between carbon emissions and consumer spending disparity in India from 1981 to 2008. The research showed no link between carbon emissions and economic disparity throughout the study period, but it did find a positive and substantial correlation following economic deregulation in 1992. The increased propensity of upstream economic groups to emit carbon due to improved access to foreign markets could explain the positive correlation between emissions and inequality after liberalization. The findings suggest that India could leverage this synergy to address environmental and socioeconomic sustainability concerns.

Khan and Yahong (2021) studied the links between income inequality, carbon emissions, and environmental consequences in 18 rising Asian nations from 2006 to 2017. The Driscoll and Kraay standard error approach was used in the research, which found a robust relationship between income disparity, carbon emissions, and ecological footprint. The findings also indicate that while population growth, easy access to energy, and foreign direct investment contribute to reducing economic inequality, they also have negative impacts on carbon emissions and environmental footprints. The study emphasizes the importance of reducing economic inequality and environmental vulnerability to achieve the Sustainable Development Goals and provides significant policy implications.

Recent research by Guo et al. (2022) examined the effects of wealth inequality and country risk on carbon emissions in nations with varying income levels. The results indicate that income inequality has a negative impact on most quantiles and is less associated with country risk. However, in low-income countries, the relationship between inequality and emissions is initially negatively correlated with reduced country risk, whereas income inequality has a negative effect on emissions in high-income countries. In both low- and high-income countries, the relationship between wealth inequality and emissions is weakened by country risk. These findings provide policy suggestions for reducing emissions.

Aye (2020) conducted a study from 2000 to 2014, analyzing the relationship between CO2 emissions and income inequality in Brazil, South Africa, Russia, India, and China. Per capita CO2 emissions and the upper decile of wealth shares were used as measures. The data indicated that financial development has a negative impact on CO2 emissions, while wealth, GDP per capita, and population inequality have a positive impact. This research underscores the importance of focusing on strategies and analytics to address social, economic, and environmental challenges.

(Liu et al., 2019) Liu et al. (2019) evaluated the short- and long-term effects of economic inequality on carbon emissions across US states using panel ARDL and a quantile regression model. The results indicate that increasing income inequality initially results in greater carbon emissions but subsequently leads to reduced emissions. Furthermore, states with higher carbon emissions per capita experience greater reductions in emissions due to wealth inequality. These insights can aid policymakers in formulating policies that mitigate climate change while promoting economic growth.

Wu & Xie (2020) analyzed the relationship between income inequality and per capita CO2 emissions in 78 OECD nations between 1990 and 2017. The research uncovered a long-term cointegration relationship between income inequality and CO2 emissions per capita. Rising wealth inequality reduces emissions in OECD and non-OECD countries with high incomes, but there are no long-term benefits in non-OECD countries with low incomes. A higher per capita national income reduces carbon emissions, while economic inequality has little direct impact. The study recommends implementing genuine programs to reform welfare systems and redistribute national income to minimize long-term emissions.

Huo & Chen (2022) assessed the influence of income inequality on CO2 emissions in rural China from 2010 to 2019. Utilizing a threshold regression model, it was determined if there is a threshold relationship between income inequality and carbon intensity in China. The study also examined the Gini coefficient of resident income in several regions of China over the same period. The results indicate that income inequality in low-income regions positively correlates with carbon emission intensity, whereas widening income inequality prevents an increase in carbon emission intensity in high-income regions. The report presents policy recommendations to bridge income inequality and reduce the severity of carbon emissions.

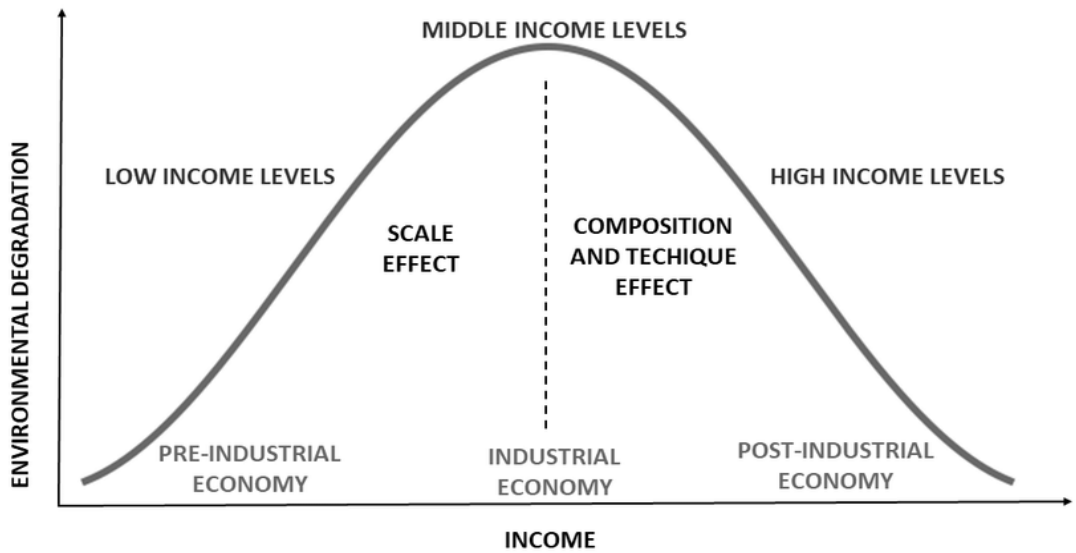
In summary, the relationship between free trade, carbon emissions, income inequality, renewable and non-renewable energy, and economic growth is a complex and diverse issue that requires further research to be fully understood. The review's research questions highlight some of the most important topics of study in this area and underline the necessity of comparing China and India, two of Asia's two biggest economies. This study can offer insight on potential policy interventions that can help solve this important issue by looking at the variables that affect CO2 emissions and wealth inequality in these two countries.

CHAPTER 3 RELATED THEORIES

3.1 Environmental Kuznet Curve (EKC)

Simon Kuznets, who originally introduced the notion of an inverted U-shaped link between economic development and wealth inequality (Kuznet, 1955), is the inspiration for the name of the Environmental Kuznets Curve (EKC). Kuznets expanded on this notion and coined the term "Environmental Kuznets Curve" in the 1950s and 1960s. The EKC builds on Kuznets' theory by asserting that patterns of economic inequality and environmental deterioration are comparable. The Environmental Kuznets Curve (EKC) theory asserts that as a country's economy expands and develops, the degree of environmental degradation initially rises but eventually reaches a tipping point and begins to decline as the country becomes wealthier and more environmentally conscious (Grossman & Krueger, 1991). This theory looks at the connection between environmental quality and economic development. It proposes that during the early stages of a country's development, when more firms enter various industries, environmental degradation increases until a certain point in the country's growth, and then declines when more prosperous and liberal communities enact procedures because they gradually value a cleaner environment.

Figure 3. Environmental Kuznet Curve



The Environmental Kuznet Curve has acknowledged a lot of consideration in the context of China's economic growth and environmental challenges. The EKC hypothesis holds for China but not for India (M. Alam et al., 2016), and it is recommended that India take steps to reduce its CO2 emissions. Researchers have investigated the connection between pollution levels, economic growth, and policy interventions. It has been noted that China does not follow the Environmental Kuznets Curve (EKC) for CO2 emissions when analyzing the effects of economic growth, the production of non-renewable energy, and international commerce (Chen et al., 2019). explores the effects of China's economic development on the environment as well as how political and economic variables influence EKC dynamics (Wang & He, 2019).

It is worth noting that the application of the Environmental Kuznet Curve theory to China and India has been met with both support and criticism. Policy interventions, institutional frameworks, technological advancements, and societal preferences all have an impact on the association between economic development and ecological quality. To gain a comprehensive understanding of the dynamics of environmental degradation and economic development in China and India, more research and analysis are required.

In accordance with the EKC theory, economic growth encourages people to care more about the environment and invest in pollution-control technology, which can eventually offset the negative environmental effects of economic growth. According to the hypothesis, as income levels increase, Consumer demand for environmentally favorable products and services, as well as consumer environmental concern. This encourages more spending on pollution prevention and cleaner technology, which slows the rate of environmental deterioration (Stern, 2004).

When industrialization has advanced sufficiently, fewer polluting service industries will emerge. Selden and Song (1995) reflect that the changes in the decline of pollution are due to technological enhancement. The Environmental Kuznets Curve (EKC) theory contends that environmental problems may be resolved through economic development. Water quality, air pollution, and ecological footprint are just a few examples of the environmental health indicators that may be analyzed using this paradigm. These variables are shown to follow an inverted U-shaped curve, showing that environmental degradation increases first as per capita income and/or GDP grow and then declines. The connection between environmental degradation and income level is determined by the elasticities of substitution of goods and household risk preferences (López, 1994). This trend is likely due to increased levels of environmental pollutants released into the air or water, such as nitrogen oxide, chlorofluorocarbons, sulfur dioxide, lead, sewage, and other chemicals. John and Pecchenino (1994) developed a model to access corresponding issues that lead to the nation’s pollution through consumption made by the people rather than production from industries. Rural areas are victims of such situations, whereas people burn down trees to get heat.

The EKC's critics contend that there are more complicated connections between economic growth and environmental deterioration than the EKC shows. For instance, according to some studies, environmental deterioration persists even in high-income regions, indicating that the turning point may not always have been reached (Levinson, 1999). Furthermore, the EKC theory ignores the effects of major environmental issues that cannot be solved only by national income development, such as climate change (Dasgupta, 2007).

Despite these objections, the EKC theory continues to be a hotly contested subject in the field of environmental economics and offers a helpful framework for examining the intricate connection between economic development and environmental sustainability. According to certain studies, government policies that support renewable energy, strengthen environmental regulations, and invest in pollution control technologies could hasten the transition to the turning point (Azomahou et al., 2006).

Finally, the Environmental Kuznets Curve theory postulates that as a nation's economy expands and develops, the degree of environmental deterioration initially rises but eventually reaches a turning point and begins to decline as the nation becomes wealthier and more environmentally aware. Although the theory has come under fire for oversimplifying the connection between economic development and environmental sustainability, it is nevertheless a useful framework for comprehending this intricate connection and influencing political choices. Through numerous investigations and research publications, the EKC idea has been examined and tested. While some of these studies have found support for the EKC, other studies have produced contradictory findings. Nevertheless, the theory offers a useful framework for deciphering the nuanced connection between economic growth and environmental sustainability as well as for informing the formulation of public policies that may quicken the transition to the turning point.

3.2 Classical economics theory

Adam Smith (1776), David Ricardo (1817), and Thomas Malthus (1798) are widely recognized as the foundational figures in the field of economic growth theory. Their contributions laid the groundwork for subsequent developments by economists like Frank Ramsey (1928), Joseph Schumpeter (1939), and Robert Solow (1956), among others. Economic growth plays a crucial role in determining living standards, and the modern era has witnessed unprecedented global disparities. These ideas cover fundamental theories of competitive behavior, equilibrium dynamics, and the effect of diminishing returns on the accumulation of human and physical capital, the interaction between per capita income and population growth rate, the impact of technological advancements like labor specialization and the introduction of new goods and production techniques, as well as the function of monopoly dynamics. They were interested in the concept of economic growth derived from a nation's progress as an essential condition. This is regarded as the advancement of society's material foundation. The analysis's objective was to pinpoint the sociocultural factors that promoted or impeded its development. As a result, progress has been made in laying the groundwork for policies and initiatives that will have an impact on those factors. According to traditional economists, social, economic, and political structures are just as important to economic growth as inputs like land, labor, capital, and technology. The sustainability of economic expansion, a major problem for traditional economists, is also addressed. The period between 1870 and 1929, known as the marginality revolution, greatly influenced the research conducted by economists, which predominantly revolved around micro-level analysis and issues pertaining to the efficient allocation of available resources (Snowdon & Vane, 2005). In this context, it is recognized that the annual income of a society corresponds to the value of its total annual output, and individuals within that society endeavor to maximize this annual income to the best of their abilities. Individuals, however, frequently promote their own interests more effectively than societal interests by preferring domestic to foreign industries. It only takes a few words to persuade them to abandon this eccentricity, which is uncommon among merchants. Ricardo (1817), who was against corn's law, argued that if the United Kingdom adopted a free-trade policy that allowed foreign countries to invest in their agricultural sectors, the nation would become the world's major net corn importer. In the population growth theorem, it was highlighted that poor people would take advantage of their abundance, causing starvation and disaster until their population was reduced to manageable levels (Malthus, 1798).

The belief is that gaining insights into the transformations of societies and economies requires a comprehensive understanding of history in general, with a particular emphasis on economic history. Wright (1997) argues that for economists to truly grasp the significance of technology, economics needs to evolve into a discipline that incorporates a historical perspective.

3.3 Neo-classical economics theory

Early in the 1870s, three schools of neoclassical economics began to take shape: Austrian microeconomics, which Carl Menger helped to develop in 1871; Walrasian general equilibrium theory, which Leon Walras clarified in 1874; and William Stanley Jevons' subjective theory of consumer behavior. In his 1890 book Principles of Economics, Alfred Marshall refined these ideas for use by contemporary economists. The main reason why neoclassical economics appears to have something to say about everything is that it is, in many ways, a methodological program rather than a single theory that can be empirically tested. The four defining characteristics of neoclassical methodology are methodological individualism, rationality, equilibrium, and the importance of the price mechanism.

According to the neoclassical theory, the interaction between supply and demand has a significant impact on how products and services are produced, priced, and consumed. Neoclassical economics is based on the core tenet that a good or service is more valuable when customers are satisfied with it than when production expenses are considered. The foundations of contemporary economics are found in Keynesian and neoclassical economic theories. The rational conduct hypothesis, which contends that humans make rational economic judgments, is congruent with the theory. People rationally choose between two options based on their perception of which is better for them.

According to the neoclassical viewpoint, a thing or service's value often outweighs its cost of creation. Neoclassical economists contest the popular wisdom that a product's worth is purely determined by its material and labor costs by arguing that customer perceptions of a product's value affect its price and demand.

Marshall (1920) reaffirmed his conviction that in order for an empirical test to fairly nearly match the theory, economic analysis must rely on models that do not include all of the variables that are relevant at a given time, which may not be necessary in other sciences. According to Lardner (1850), one of the era's most unique "neoclassical" contributions was made by a railway engineer and astronomer. Concepts for the "neoclassical" theory of business, including concepts about the price of transportation services, the actions of simple and discriminating monopolies, company location, and profit maximization theory, abound in his book Railway Economy (1850). A demand curve was suggested but not specifically drawn in Lardner's graphical model.

3.4 Modernization theory of urbanization

The modernization theory of urbanization is a theoretical framework that was developed in the middle of the 20th century to explain how traditional societies became contemporary ones. The idea contends that as nations transition from conventional agricultural-based economies to industrialized, urbanized ones, urbanization is both a necessary and unavoidable part of modernization. The modernization theory of urbanization, economic growth, technical developments, and changes in social and cultural values all contribute to the progress of urbanization. Urban industrial output replaces rural agricultural production as societies become more industrialized and economically advanced. As a result, more people move into metropolitan areas, and alterations are made to how people interact, live, and work.

The theory of modernization has been applied to understand China and India's respective paths of development and transformation. However, it is important to remember that the idea of modernization has changed through time, and there are several interpretations and viewpoints on how to apply it. Economic reforms and a shift toward a market-oriented economy have characterized China's modernization. The modernization theory has been used to examine China's transition from a primarily agrarian society to an industrialized and urbanized nation.

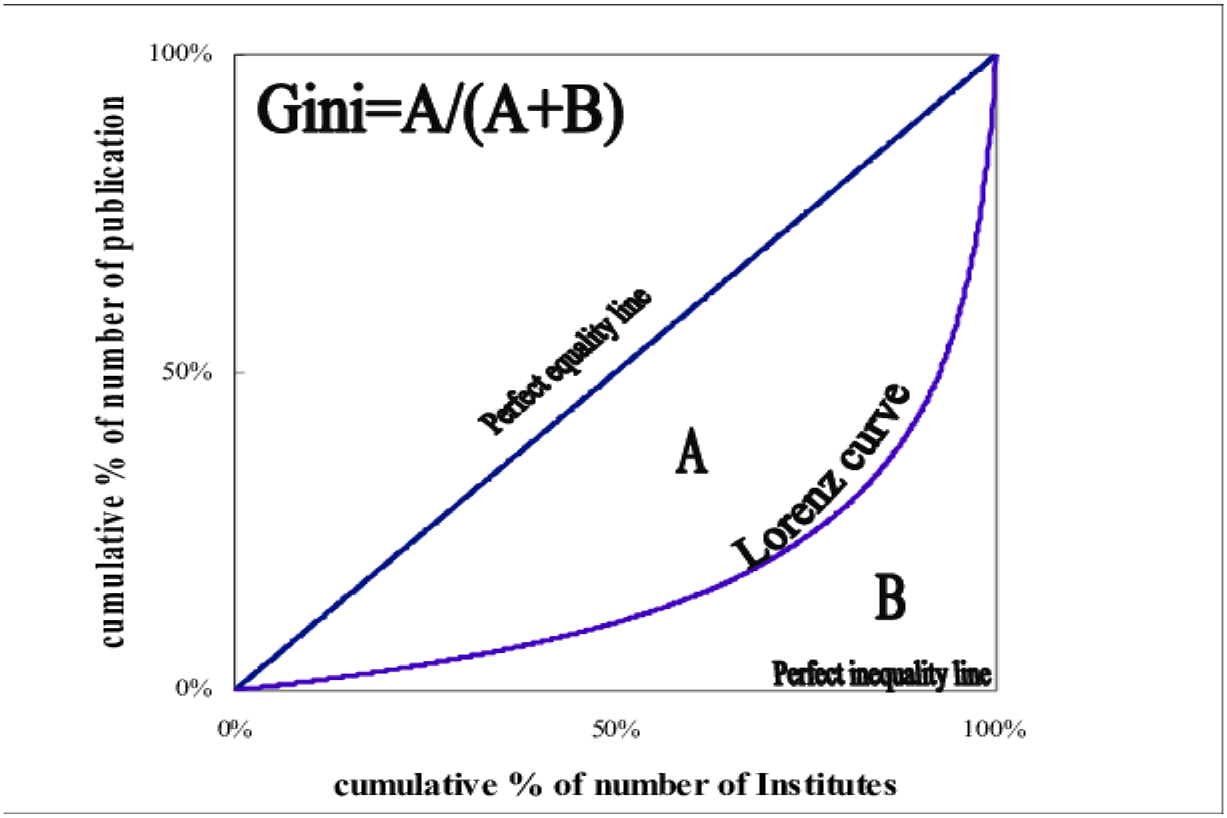
China's modernization, according to Fei (1992), a prominent Chinese sociologist, involved a dual process of "urbanization" and "industrialization." This viewpoint emphasizes the significance of urban development and industrial growth as critical components of China's modernization process. Modernization theory has been used in India to identify the country's transition from a colonial economy to an independent, industrialized nation. Economic liberalization, democratic governance, and social transformations have all been part of India's modernization. The book "The Discovery of India" by Jawaharlal Nehru, India's first Prime Minister, is an influential work on modernization in India. (Nehru, 1946) discussed the modernization process and the challenges that India faces in achieving economic and social progress. It's worth noting that the theory of modernization has been chastised for its Western-centric perspectives and assumptions. Some academics argue that the theory fails to account for the diverse cultural, historical, and institutional contexts of countries such as China and India. As a result, while modernization theory can provide insights into their development processes, it should be supplemented with other frameworks and theories for a more complete understanding.

According to the argument, urbanization promotes modernization because it creates more opportunities for social and economic advancement. It is suggested that urbanization promotes more worker specialization, higher production, and resource use. Furthermore, metropolitan settings offer easier access to healthcare, education, and other services, which can raise overall living standards.
Moreover, the modernization hypothesis of urbanization has drawn criticism for failing to take into consideration urbanization's detrimental effects, particularly in developing nations. Many social and environmental problems that might arise from urbanization, according to critics, include overcrowding, pollution, and urban poverty. Additionally, when the wealth disparity between urban and rural people widens, urbanization may worsen social inequality., the modernization hypothesis of urbanization is still a key idea in research on urbanization and development, notwithstanding these objections. To address some of the critiques and take into consideration the complex and dynamic nature of urbanization, it has been updated and improved over time.

3.5 Gini coefficient and Lorenzo curve theory

The Gini coefficient can be used to calculate the degree of income or wealth disparity within a population. It was developed in 1912 by Italian statistician Corrado Gini, and economists, policymakers, and social scientists regularly use it to determine the degree of inequality in a community. The most significant measure for assessing or evaluating income disparity is the Gini coefficient (Sen, 1997; Champernowne & Cowell, 1998). It is all more commonly used than any other means of measurement.

Figure 4 Gini Coefficient



The Lorenz curve provides a comparison between the cumulative proportion of wealth or income at different percentiles of the population and the overall cumulative percentage of the population. On the other hand, the region below the line of perfect equality is divided by the space between the Lorenz curve and the line of perfect equality to get the Gini coefficient. In 1912, Italian statistician Corrado Gini published "Variability and Mutability," which included a technique for measuring inequality, which later evolved into the well-known Gini coefficient. Both the Lorenz curve and the Gini coefficient serve as metrics for evaluating the degree of income or wealth inequality within a given population. They offer a succinct and consistent measure that can be applied to evaluate the differences between cultures or monitor the evolution of inequality over time. In debates about inequality and poverty, policymakers and politicians frequently use the Gini coefficient, which has been widely employed in economic and social studies.

There are several critics of the Lorenz curve hypothesis and the Gini coefficient. One complaint is that they ignore non-financial measures of wealth, including social capital, health, and education. Another complaint is that they don't discuss the factors that contribute to inequality or how income is distributed among various racial and socioeconomic groups. Finally, some academics contend that the Gini coefficient is overly straightforward and can be deceptive when employed in isolation from other measures of social and economic well-being.

The Lorenz curve hypothesis and the Gini coefficient are nonetheless effective instruments for assessing income and wealth inequality within a population, despite these objections. They offer a standardized and simple-to-understand measure of inequality that may be used to assess differences in inequality between societies or over time.

Chapter 4

The Factors Affecting Income Inequality in an Economy-The Solutions to solve the income inequality.

4.1 Introduction

Income inequality is a central problem in modern societies around the world. The extent and impact of income inequality vary across countries, and its impact can be far-reaching, affecting economic growth, social cohesion, and individual well-being. Due to differences in talent, effort, and well-being, there will always be some degree of inequality in a market-based economic system. However, excessive disparity undermines social cohesiveness and fuels political conflict. In the end, it may stop economic growth (Berg et al., 2018).

The 19th century and most of the 20th century saw a sharp rise in global inequality, which was a result of growing gaps in per capita income across nations as industrialized nations achieved relative affluence. A new age of wealth and development was inaugurated by the rebirth of international economic cooperation in the middle of the 20th century. Because of this, Asia's least developed nations' per capita GDP growth quickened, causing income levels in those nations to converge (Bourguignon, 2015). Families in the millions have been rescued from poverty. Consequently, worldwide income disparity originally stabilized, but over the last three decades, it has substantially decreased. It could nonetheless be highlighted that not all parts of the globe have an equal distribution of wealth between industrialized and developing nations. For instance, income growth in sub-Saharan Africa is less rapid than in Asia. The difficulties presented by COVID-19 are likely to undercut some of the gains made in decreasing global inequality. Since wealthy nations often have more resources to cope with the effects of the pandemic and subsequent recovery efforts, global inequality will almost certainly grow. In conceptual and empirical investigations, several global and regional reasons for income inequality trends have been put forward. Among the crucial forces are:

The development of technology, globalization, and cycles in commodity prices are significant worldwide drivers. For instance, since people with greater education have a competitive advantage when adopting new technologies, technological advancements lead to a skills premium (Card and DiNardo, 2002). Employment polarization, a phenomenon brought on by technological advancements, is also causing a drop in middle-class jobs in Western Europe and the United States

(Goos and Manning, 2007). Domestic policies like financial integration, redistributive fiscal policies, liberalization of labor and product markets, and deregulation, as well as country-specific variables like economic progress and stability, all contribute to understanding patterns of domestic inequality.

4.2 The Factors Affecting Income Inequality

Whether higher values of a specific calculation led to a higher or lower imbalance depends on the characteristics of the financial framework and the countries' level of advancement. Causality is also often problematic. For example, there's no agreement on the course of the relationship between salary disparity and financial improvement. A few observers consider the idea that development influences imbalance, whereas others find that imbalance influences development. Typically, this is conceivable since the causal relationship between financial improvement and salary disparity can be followed by an assortment of causes.

Economic growth and the overall development level of a country.

It involves economic structure, which refers to GDP growth, technological progress, and the share of agriculture, industry, and service sectors. There's a ponder detailing a modified U-shaped association between normal pay and pay disparity, to begin with, as proposed by Kuznet (1955). Growth at lower levels of development initially increases inequality but ultimately decreases it at higher levels of development. But information from the movement prepares and numerous considers cast question on Kuznets' considering. In this manner, it makes sense to explore the links between GDP development and disparity, utilizing other pointers that characterize a country's level of improvement. One of these pointers can be the rate at which the populace works in several divisions. There's evidence that disparity increases when a huge portion of the populace moves to more advanced segments (e.g., from agribusiness to industry). However, when immigration stops, income distribution returns to normal (Gustafsson and Johansson, 1997). Technological advances can lead to wage inequality, as demand only increases for skilled workers, making them more productive. However, these changes can be prevented by appropriate changes in education policy (Cornia and Kiiski, 2001).

Inflation and unemployment are macroeconomic determinants.

Factors such as government spending levels, external debt and reserves, and exchange rate fluctuations. Above all, high inflation exacerbates inequality by redistributing resources to those with fixed nominal incomes, often socially less secure and poorer segments of the population. On the one hand, inflation can reduce the income distribution of the wealthy through progressive taxation (Gustafsson and Johansson, 1997). According to Gustafsson and Johansson (1997), there appears to be an expanding effect of unemployment on imbalance since higher unemployment compounds the circumstances for those at the bottom of the salary distribution. There's a course of effect on trade rate bungles and other variables related to the worldwide economy that is questionable. The effect of government investing depends on its composition, particularly the share of social exchanges in open investing. For illustration, when outside obligation increments, intrigued installments increment, taking off less for social exchanges and diminishing the redistributive impact of government investing (Cornia and Kiiski, 2001).

Demographic variables improvement.

Demographic development processes such as population age structure (labor force share), population growth and density, urbanization, level of human capital counting instruction level, and populace wellbeing status. Densely populated countries have lower inequality than less populated countries. In the latter case, land is likely to be concentrated, increasing inequality in capital income. Human capital, especially education, is also important. Studies appear to indicate that the relationship between instructive extension and disparity is an altered U. Within the early stages of improvement, the imbalance broadens as the population's expanding level of instruction increases livelihoods for more skilled specialists. Further growth and equalization of educational attainment will equalize income distribution and reduce inequality (Cornia and Kiiski, 2001).

Political impacts incorporate privatization and private segment share, tax collection and open division share, and country openness, especially openness to trade and free movement of workers. Socio-political and other economic policy decisions. (Durham et al., 1999) investigated the type of government as a factor causing inequality. In any case, for illustration, most created nations with moo imbalance are majority rule governments, but moo disparity may be due to higher levels of improvement, so no firm conclusions can be drawn around the impact of administration sort. .

In developed nations, privatization leads to shifting degrees of wealth concentration and a more unequal distribution of salaries. Salary disparity is frequently lower within the public segment than within the private division. Hence, the greater the share of the open division within the economy, the lower the overall imbalance (Gustafsson and Johansson, 1997). In addition, territorial measures to advance urbanization will lead to a greater disparity in wage dispersion between urban and provincial populations. Expanded financial openness in creating nations seems to lead to more noteworthy requests for low-cost labor and hence diminished imbalance, but the by and large relationship between exchange openness and pay disparity is vague (Cornia and Kiiski, 2001). A negative affiliation has also been found between the greatness of social exchanges and pay redistribution and salary disparity (Caminada and Goudswaard, 2001), although redistribution too influences work and speculation choices. It remains hazy to what degree and in what heading imbalances will emerge. Influenced by tax collection and social exchanges. Chronicled, social, and natural components such as the dispersion of arrival residency, people's demeanors towards imbalance, and the degree of the casual economy have all advanced over time. Separate from that, there's one more thing to consider.

Accessibility of normal assets.

Nations with characteristic assets tend to have higher disparities due to capital-based innovation and a diminishing need for incompetent labor (Cornia and Kiiski, 2001). Imbalance is apparently more prominent in nations where normal assets and cash have gathered over time within the hands of a small division of the populace (Cornia and Kiiski, 2001). At last, social researchers have found links between the social characteristics of social orders and wealth disparity (Mushinski & Pickering, 2000).

4.3 INSIGHTS IN CHINA AND INDIA

India's income inequality is a persistent and pressing problem in many countries, often causing significant social, financial, and political challenges. China and India, the two most crowded nations in the world, have experienced remarkable economic growth and transformation over the last few decades. Asia and the Pacific have enjoyed tremendous economic development and poverty reduction over the past two decades, surpassing Latin America and the Caribbean with 9.9% annual GDP growth each, mostly due to the outstanding performance of China and India. and is expected to reach 6.4% (Zhuang, Kanbur, & Rhee, 2014). The causes and implications of growing inequality in emerging Asia, as well as policy solutions for addressing the problem, such as decreasing human capital inequality, encouraging employment development, limiting geographical gaps, and improving governance to remove social exclusion and level the playing field, However, parallel to these advances are growing concerns about income inequality in both countries. This paper comprehensively presents the situation of pay disparity in China and India and examines its causes, consequences, and possible policy responses. Since the late 1970s, China has seen fast economic development, pulling millions out of poverty and significantly increasing their living conditions (Fan, 2006). However, this amazing progress has been accompanied by an increase in economic disparity. The Gini coefficient, a broadly utilized degree of pay imbalance, has grown dramatically in China in recent decades, indicating a growing disparity between the affluent and poor. One of the main reasons for income inequality in China is the move from a centrally arranged economy to a market-oriented economy. The transition has created a new class of entrepreneurs and high-income earners, while many workers in traditional state-owned enterprises face job insecurity and falling wages (Kolodko, 2002). Rapid urbanization and industrialization are also creating regional disparities, with coastal areas benefiting more from foreign investment and export-oriented industries, while inland and rural areas are being left behind.

birth. Another factor contributing to income inequality in China is the hukou system, a hukou system that restricts access to social welfare based on place of birth. The system perpetuates the divide between rural and urban areas, limiting the movement and opportunities of rural migrants moving to urban areas in search of work (Li, 2017). Moreover, the concentration of riches and control within the hands of state-owned ventures and the politically linked elite has exacerbated income inequality. Nepotism and corruption allow a few individuals and businesses to amass enormous wealth while most of the population struggles to make ends meet.

India, compared with China, has experienced significant economic growth in recent decades, but income inequality remains a persistent problem. The country's Gini coefficient is also on an upward trend, reflecting the widening income gap between different social classes. The ancient caste system, which has resulted in persisting social divides and discrimination, is one of the primary causes of wealth disparity in India. Destitution and a need to get access to not-too-bad instruction, wellbeing care, and financial openings disproportionately impact those from lower castes and disadvantaged groups (Tandale, 2021). These social inequalities have led to economic inequalities and perpetuated a vicious cycle that has disadvantaged certain groups. Another factor is the unequal distribution of land and resources. Agriculture is an important sector that employs a significant portion of the population, but it has low productivity and inadequate infrastructure. The control of vast tracts of land by a few wealthy individuals means that many farmers are trapped in subsistence farming, exacerbating urban-rural inequalities. India's rapid urbanization is also leading to income inequality. While cities offer more employment opportunities and higher wages, the rapid influx of immigrants from rural areas strains infrastructure and public services, creating slums and inadequate livelihoods for many city dwellers. Moreover, gender inequality plays a significant role in India's income inequality. Women face numerous challenges, including limited access to education, limited employment opportunities, and wage discrimination. These factors contribute to the gender pay gap, leaving women behind.

4.4 THE SOLUTIONS TO ENHANCE INCOME INEQUALITY.

Factors that drive rising inequality also drive increases in productivity and incomes. Policymakers should therefore not impede the development of these forces. Distinguish between income inequality caused by unequal access to market opportunities and public services and income inequality that arises as economies and people embrace new opportunities offered by technological advances, trade reforms, and efficiency-enhancing reforms (Zhuang et al., 2014). This second type of inequality requires political action because it amplifies the drivers of development, creates inefficiencies, and threatens the sustainability of growth.

Promoting educational equity:

Moving forward social versatility by making instructive fulfillment less dependent on individual and societal conditions ought to upgrade GDP per capita by making strides toward enterprise, common human capital quality and allotment, and, eventually, efficiency. At the same time, it has appeared that a reasonable conveyance of instructive conceivable outcomes leads to a more even-handed dissemination of labor wages (Gregorio & Lee, 2002). Changes incorporate deferring early following, progressing ties between school and home to help distraught children learn, and providing all children with early childhood care and fundamental instruction. The last mentioned may give critical positive returns all through an individual's lifetime, particularly for the most impeded (Chetty et al., 2011).

Closing the employment protection gap between temporary and permanent work:

On the off chance that work security is altogether harder for standard contracts than for brief contracts, representatives on the fringe of the labor market, such as youthful individuals, have a chance of being bolted into a cycle of brief work and unemployment without ever finding a changeless job. This may have a negative effect on human capital and career progression (OECD, 2004), as well as pay uniformity and financial improvement. According to a modern OECD ponder, low-wage workers on brief contracts gain less than people with comparable characteristics on changeless contracts (Fournier and Koske, 2012). Typically, this is not genuine for higher-income workers. As earlier inquiries have illustrated, workers suffer excessively from contract-related work advertising dualism (Causa and Jean, 2007). More impartial employment security for brief and changeless contracts is additionally likely to reduce the wage contrast between migrants and non-immigrants.

Improving Education's Quality and Reach:

Moving forward Education's quality and reach Human capital changes are basic for raising living benchmarks and are moreover likely to play down work-pay dissimilarity. According to a new investigation, an increase in the proportion of workers with a postsecondary degree is associated with a decrease in labor wage disparity (Fournier and Koske, 2012). Arrangement endeavors to extend upper auxiliary instruction accomplishments and incorporate, among other things, more obligation for schools, moved forward instructor enlistment and preparation, and particular help for understudies at risk of dropping out. Expanding the number of understudies who look for postsecondary instruction may have a vaguer impact on compensation disparity. Such measures are likely to increase wage imbalances by raising the number of high-wage specialists (the composition effect). In any case, it appears that this advantage may be more than compensated by a drop in higher instruction returns compared to lower levels of instruction (Koske et al., 2012). Educational cost expenses that require understudies to contribute at least a parcel of the fetched of higher instruction might diminish the expendable wage imbalance (since existing instruction financing is backward), given they are coupled with flanking arrangements that guarantee the destitute are not banished from tertiary instruction.

Spending on active labor market policies should be increased.

Tall social preferences might lower the inspiration to work and discover a job. Dynamic labor advertising arrangements may aid relieve these negative results by better matching occupations to gifts, making strides in work look helpful, and checking. Existing observational inquiry demonstrates that dynamic labor showcase methodologies do certainly increase business (Bassanini and Duval, 2006). This ought to have a favorable effect on GDP per capita as well as the labor wage balance. Be that as it may, a program plan is essential to harvesting such benefits (Martin and Grubb, 2001).

Promotes the integration of immigrants.

Joining transients into the labor market through expanded labor drive interest can decrease imbalances and make strides in GDP per capita. Focused endeavors, such as dialect courses and clear components for the acknowledgment of outside certificates, ought to help in diminishing execution crevices within the labor market between foreigners and non-immigrants.

Improving labor market outcomes for women.

Women tend to bear more caregiving duties than men, resulting in fewer hours' work and thus lower compensation. A few contend that ladies ought to be saddled less than men since of their more adaptable labor supply (Rubery et al., 2016). As is usually not practically doable, endeavors to progress formal care for children and the elderly may be utilized as an elective. Such measures ought to aid kill sexual orientation disparities in working hours and compensation, at least to the degree that hourly compensation is not influenced, while at the same time making strides in living measures within the long run through expanded labor drive interest.

Fight discrimination

Separation is likely to be at least incompletely mindful of wage incongruities between foreigners and nonimmigrants and between men and ladies, so more compelling legitimate limitations exist (e.g., lawful activity against people included in biased exercises). Being required, moreover, makes a difference. Income disparity is a complicated problem driven by a variety of variables, including education, technology, globalization, labor market systems, discrimination, and social issues. To reduce income disparity, multifaceted initiatives such as progressive taxation, investing in education and skills development, improving labor market institutions, boosting entrepreneurship, increasing social safety nets, and tackling gender inequality are necessary. Policymakers may aim to reduce economic gaps and build a more equitable and inclusive society by adopting these ideas.

Chapter 5

The Impacts of Economic Growth on the Environmental Quality

5.1 Introduction

Economic development and environmental issues are fundamentally concerned with the nature of the weights that economic extension applies to the environment over time, both locally and universally. The relationship between the environment and economy is picking up significance as individuals become more mindful of the effect of financial movement on the maintainability and quality of the world (Lenzen et al., 2020).

Economic development is portrayed as an increase in general generation due to the expansion of assets or more prominent utilization of existing resources, as measured by the increment in genuine per capita pay. Economic development brings about changes within the characteristic world, and on the quality of the environment, it can have three impacts (Liang & Yang, 2019). Development has the potential to improve the quality of the environment. For illustration, expanded salary reserves open administrations such as sanitation and country vitality supplies. Since these administrations are broadly accessible, people may stress less about their day-to-day survival and be able to donate more assets to preservation. In addition, as growth rates rise, environmental quality may deteriorate initially but may improve later. With air pollution, water pollution, deforestation, and encroachment prevalent, no one has an incentive to invest in preserving environmental quality. These problems will only improve if governments implement long-term plans and dedicate more resources to addressing them. Third, environmental quality may deteriorate as the pace of expansion accelerates. Emissions from municipal solid waste treatment are costly to abatement but are not considered high because the costs associated with emissions and waste are usually borne by someone.

Based on current productivity trends and projected population growth, the World Bank estimates that by 2030, developing countries will produce about five times as much as they do today. Copper developed countries' production will increase threefold over the same period, albeit more slowly. If pollution continues to increase at its current rate, it will cause serious environmental problems. Environmental impacts will make tens of millions of individuals sick and die and will cause severe and irreversible damage to the planet. However, economic development and good environmental management are not mutually exclusive. In fact, many today consider it mutually beneficial.

Without proper environmental protection, economic development is hampered, and environmental protection fails. Economic development is constrained by the earth's natural resources. These limits vary according to resource substitution, technological advancement, and the level of structural change. For example, in the late 1960s, there was concern that the global supply of precious metals would be exhausted. However, there is now a glut of available metals, and prices have fallen significantly. Demand for other natural resources, such as water, often exceeds available resources. In arid regions such as the Middle East and non-arid areas such as northern China, aquifers have dried up and most rivers have dried up, threatening not only irrigation and agriculture but also local ecosystems (Xue et al., 2015).

Some resources, such as water, forests, and clean air, will be attacked, but others, such as metals, minerals, and energy, will not. This is because market prices reflect the rarity of metals and related commodities. Factors of resource substitution, technological growth, and structural change play an important role here. However, since resources such as water are freely available, there is no incentive to conserve them. Many believe that good environmental governance is essential, as society needs to be educated to appreciate the value of characteristic assets and governments must motivate them to ensure the environment.

In the long run, promoting development, eradicating poverty, and protecting the environment are mutually beneficial goals, but in the short term, they are not necessarily compatible. Poverty is the main cause of environmental degradation; therefore, economic growth is necessary to restore the environment. However, uncontrolled economic growth threatens the environment and the livelihoods of the poor. In many poor but still forested countries, timber is an excellent source of short-term foreign exchange. Due to the lack of demand for oil, Indonesia's main export, and a decrease in foreign exchange earnings, the country has begun to clear hardwood forests at an unsustainable rate to generate export revenue. The presence of competition in developed countries can shorten the time. For example, the competitive nature of agricultural markets causes producers to take a short-term financial perspective. Farmers need to maintain a steady stream of income to reward financiers and generate a satisfactory return on their land investment. As a result, they use high yielding, eroding crops, monocultures, more fertilizers and pesticides, saltwater irrigation techniques, and more aggressive farming methods.

The Commons tragedy is a famous illustration of property rights disappointment. When shepherds have unlimited contact with pastures, they find that the grass they don't eat today will be gone tomorrow. All pastoralists, as rational economic agents, seek to maximize their profits by adding more animals to their herds. Pastoralists have no motivating force to anticipate cattle grazing within the area. Degradation and loss of shared resources occur. In a society where property rights are not clearly defined, those who pursue personal gain undermine the common good (Marginson, 2018). Similar situations are caused by global or transnational problems such as ozone depletion and acid rain. If a country's unilateral reduction of damage to the global environment does not reduce the harmful behavior of other countries or place itself at a competitive disadvantage, then there is limited incentive for a country to unilaterally reduce. Therefore, an international treaty equivalent to property rights is needed to impose order on the nations of the world.

The concentration of riches in wealthy nations empowers the misuse and pulverization of environments in the least created nations (LDCs) through exercises such as logging and mineral extraction (Estrada et al., 2018). The concentration of wealth in developing countries shifts public policy in favor of the rich and political powers, regularly at the cost of the environments upon which the destitute depend. Local supportability is decided by the objectives of those in control, but we do not know if that is compatible with healthy and sustainable ecosystems. Additionally, if the abusing party has access to a surrogate ecosystem, they may abuse one ecosystem before moving on to the next. Japanese logging companies harvest in one country and then move on to the next. Sustainability gains are limited in this context, as exploiters' profits are shorter than local ones. This is also an example of how high discount rates in developed countries strain wealth management in developing countries.

Environmental policy decisions are always more than just assessing the environmental impact of proposed measures. Due to the scientific ambiguity surrounding biophysical and geological relationships and the general difficulty in estimating the environmental impact of policies, policy decisions are based on economic rather than ecological impacts (Keenan, 2015). Policymakers and institutions do not understand the direct and indirect impacts of policies on environmental sustainability and how policy actions affect communities beyond their control. I don't understand how it works either. Many modern economists and environmental activists argue that environmental values should be considered when making economic policy decisions. The aim is not to assign financial value to environmental resources. Rather, it is important to assess how much climate quality is being sacrificed in the name of economic development and how much growth is being sacrificed in the name of environmental protection. Failure to define and minimize trade-offs and take actions that benefit both economic development and the environment always risks unduly sacrificing future income growth.

5.2 Positive Impacts of Economic Growth on the Environmental Quality

The link between economic development and environmental quality has sparked substantial discussion and concern in recent years. Economic expansion has historically been seen as harmful to the environment, since industrialization and greater consumerism have often resulted in pollution, depletion of natural resources, and habitat damage (Ukaogo et al., 2020). Economic development that is pursued in a sustainable manner may have a beneficial impact on environmental quality. This section looks at and evaluates the beneficial effects of economic growth on environmental quality.

To raise living standards and amass riches, most governments set economic growth as a top priority. Economic development is the increase in a country's generation and utilization of items and services. Pollution, deforestation, and carbon emissions are only some of the environmental problems that have long been connected to economic growth. However, recent research and advancements in sustainable development have shown the possibility that economic growth might enhance environmental quality (Pradhan et al., 2017).

Technological and inventive breakthroughs have a critical role in achieving good environmental change in the context of economic growth. Businesses and industries have a stronger motivation to invest in research and development (R&D) to improve manufacturing methods and generate sustainable alternatives as economies expand (Chesbrough & Crowther, 2006). As a result, technologies that decrease pollution, increase energy efficiency, and reduce resource use have been developed. For example, economic development has aided the expansion of renewable vitality advances such as solar orientation and wind control, making a difference in diminishing greenhouse gas outflows and advancing the move to low-carbon economies. Adoption of these cleaner technologies and practices improves not just environmental quality but also resource efficiency and corporate operating costs.

Additionally, economic success may raise environmental awareness among people, corporations, and governments. Environmental awareness and the long-term advantages of environmental conservation are regularly stressed as nations grow more economically successful. Individuals with higher income levels might emphasize environmental problems, leading to the adoption of sustainable consumption habits such as a preference for eco-friendly items and energy-efficient technology (Leonidou et al., 2010). Businesses that realize the benefits of sustainability as a competitive advantage are increasingly incorporating environmental issues into their operations. Furthermore, when economic development produces money for environmental protection activities, governments and politicians are more inclined to enact environmental legislation and policies.

Conservation activities are another good consequence of economic development on environmental quality. As a society's wealth grows, it has more resources to devote to the preservation and repair of ecosystems. Economic development may help to empower the creation of ensured ranges, the advancement of economical arrival and woodland administration hones, and the assurance of biodiversity (Munthali, 2007). Economic success, for example, promotes the development of national parks and protected wildlife sanctuaries, protects vital natural ecosystems, and promotes the survival of endangered species. Furthermore, economic development may make it easier to apply sustainable agricultural methods that limit the use of harmful chemical inputs while also encouraging soil and water conservation.

Additionally, increased R&D funding helps create eco-friendly innovations and practices as the economy expands. Spending more on research and development might lead to eco-friendly farming practices, manufacturing processes, and the smarter use of scarce materials. New wastewater treatment technologies have emerged because of rising prosperity, reducing water pollution, and protecting aquatic habitats (Pradhan et al., 2017). Similarly, increased income has spurred the growth of environmentally friendly farming practices like organic farming and precision farming, which maximize productivity with little waste of natural resources.

Economic development may provide chances for green employment in addition to having a direct beneficial impact on environmental quality. A skilled work force capable of planning, implementing, and sustaining sustainable practices is required for the move to a more feasible economy. As a result of financial development, green jobs may be produced in industries such as renewable energy, energy efficiency, waste management, and environmental consulting (Wei et al., 2010). These green vocations not only provide jobs but also encourage the development and deployment of sustainable technology and practices, therefore contributing to environmental conservation.

Another advantage of economic growth is environmental education. As countries grow more economically developed, greater emphasis is put on education and information distribution. This is an excellent chance to raise environmental awareness and urge people to partake in sustainable behavior. Environmental education programs, both official and informal, may foster a feeling of environmental responsibility and empower people to make choices that improve environmental quality (Dresner et al., 2015). Climate change, biodiversity protection, and sustainable resource management are examples of programs that may provide people with the information and skills needed to handle environmental concerns.

Although economic expansion has typically been associated with negative environmental repercussions, it is vital to understand the potential benefits it may have for environmental quality. Economic growth may promote sustainable practices that improve environmental preservation and resource efficiency via technological advancements, improved environmental consciousness, conservation activities, research and development, green job creation, and environmental education. Societies may harness the energy of economic growth to achieve both economic success and environmental sustainability by acknowledging these favorable consequences and implementing laws and policies that promote sustainability.

5.3 Negative Impacts of Economic Growth on the Environmental Quality

Economic development has long been seen as a primary goal for governments across the globe, since it is thought to promote progress, raise living standards, and increase general social well-being. However, the quest for economic progress often comes with a tremendous environmental cost. Because of the rising understanding of the limited nature of our planet's resources and the urgent need to address climate change and biodiversity loss, the hindering impacts of financial extension on natural quality have been a major issue for a long time. The purpose of this section is to explore and look at the negative highlights of financial development and its negative consequences for environmental quality. Energy, natural resources, and raw materials are in high demand as countries grow and industrialize. This has several negative environmental implications, including pollution, habitat damage, deforestation, and greenhouse gas emissions. To meet the energy needs of developing industries and the transportation sector, the burning of fossil fuels, especially coal, oil, and gas, contributes significantly to air pollution and greenhouse gas emissions. Emissions of carbon dioxide (CO_2) and methane (CH_4) are major drivers of climate change, causing global warming, ice sheet melting, sea level rise, and more frequent and severe weather events (Krishnan et al., 2020).

The phenomenon of the "environmental Kuznets curve" has been proposed to explain the link between economic development and environmental degradation. According to this idea, environmental degradation worsens during the early phases of economic growth but improves as income levels increase. According to the theory, as nations get wealthy, they can afford to invest in cleaner technology and establish environmental rules to counteract the detrimental effects of economic activity (Truby, 2018). While this theory provides some promise for future environmental improvements, it is critical to recognize the enormous hurdles and repercussions connected with the detrimental effects of financial development on environmental quality.

Pollution is one of the greatest inconvenient impacts of financial development on the environment. Poisons are discharged into the environment, water, and soil because of mechanical action, transportation, and energy generation. Air pollution, produced by pollutant emissions from automobiles, industry, and power plants, not only harms human health but also contributes to poor air quality and climate change (Manisalidis et al., 2020). Water pollution from industrial waste discharge, agricultural runoff, and ineffective waste management endangers aquatic ecosystems and human health. Soil contamination, which is often caused using pesticides, chemical fertilizers, and inappropriate waste management, reduces soil fertility and reduces agricultural production.

The depletion of natural resources is another big negative consequence of economic progress. Energy, minerals, and raw commodities are in high demand as economies expand. These resources are often extracted and used at an unsustainable pace, resulting in depletion and irreparable harm to ecosystems. Extraction of fossil fuels, for example, not only adds to greenhouse gas emissions but also leads to the depletion of natural resources (Shrivastava & Hart, 1995). Deforestation caused by agricultural land expansion, logging, and urbanization not only results in the loss of critical habitats, but it also upsets ecological balance and contributes to climate change.

Rapid urbanization, a frequent result of economic expansion, creates considerable environmental issues. As cities grow, natural landscapes are transformed into concrete jungles, resulting in the loss of green areas, biodiversity, and ecosystem services. (Kabisch, 2015) Large volumes of trash are generated in cities, putting pressure on waste management systems and often resulting in ineffective disposal methods such as landfilling or incineration, which add to pollution and greenhouse gas emissions. Furthermore, urbanization increases energy consumption and transportation demand, resulting in increased air pollution, traffic congestion, and noise pollution.

Economic growth's detrimental effects on environmental quality are not restricted to local or regional dimensions but have global ramifications. Climate change, caused by greenhouse gas emanations from economic action, is a worldwide issue with far-reaching repercussions. Rising global temperatures disturb ecosystems, have a negative influence on agricultural output, increase the frequency and intensity of natural catastrophes, and endanger vulnerable people (Costello et al., 2009). Furthermore, biodiversity loss and habitat degradation caused by commercial activities have long-term effects on ecosystem stability, resilience, and the provision of fundamental environmental services such as water filtration, fertilization, and carbon sequestration.

Agriculture's expansion, fueled by economic prosperity, has had a significant detrimental influence on the environment. To fulfill rising food and commodity demand, massive amounts of forest and natural habitat have been removed, resulting in deforestation and habitat devastation. This biodiversity loss not only endangers many plant and animal species, but it also impairs ecosystem functioning and resilience (Bengtsson et al., 2000). Chemical fertilizers, herbicides, and intensive agricultural techniques all contribute to soil erosion, water pollution, and soil fertility loss. Unsustainable farming practices worsen water shortages and contribute to freshwater resource loss.

Finally, even though economic expansion is often desired as a way of achieving social progress and well-being, it is critical to acknowledge and address the negative effects it has on environmental quality. Among the key issues linked to economic expansion are pollution, habitat degradation, deforestation, and climate change. To mitigate these negative repercussions, it is critical to promote sustainable development practices, shift to cleaner and more resource-efficient technologies, and embrace responsible consumption and production habits. It is critical to strike a balance between economic development and environmental conservation to ensure a sustainable and resilient future for current and future generations.

Chapter 6

International Trade and Its Impacts on the Environment

6.1 Introduction

International trade, also known as foreign trade, plays a crucial part in the worldwide economy, but its impact on the environment is a topic of growing concern. The exchange of goods, services, and resources across national borders has both positive and negative effects on the environment (Jorgenson, 2006). According to economic theory, international trade promotes economic development and increases well-being. Nevertheless, the debate over the best approach to balancing trade and environmental issues shows how difficult it is to generalize.

In truth, there are a few reasons for and against foreign trade, as well as ways to analyze its potential natural effects. On the other hand, a few natural groups contend that exchange liberalization is one of the most common causes of natural corruption since it boosts financial development and increases worldwide requests for characteristic assets (Nasir et al., 2021). On the other hand, proponents of global trade liberalization argue that trade has long-term environmental benefits. They also argue that increased international trade will lead to higher income levels, which in turn will lead to increased demand for better environmental quality, leading to stricter environmental standards and regulations and the need for goods produced in environmentally friendly conditions. There is also a middle ground closer to the concept of sustainable development, where trade-driven growth requires appropriate policies and a stringent environment to reverse the degradation and depletion of oceans, air, freshwater resources, species, soils, and climate. Arguing that regulation must accompany. Proponents of this position accept the introduction of restrictions in multilateral agreements to control resource degradation and protect consumers from the importation of harmful goods without openly opposing free trade. This stance recognizes that international trade can help make the planet's resources more efficient and sustainable, as long as the prices of resources reflect the costs of actions that harm the environment (McAfee, 1999). It is also recognized that trade and investment can help accelerate the deployment of clean technologies that reduce negative impacts on production and consumption.

The link between trade and the environment is particularly important in agriculture. Agriculture is the economic sector most closely linked to the utilization of common resources, particularly water and soil. Agricultural production, especially in traditional agriculture, is closely related to the utilization of these resources, as are other environmental benefits derived from biodiversity, such as pollination. Moreover, agricultural growth is often accompanied by land-use changes, such as the transformation of forests and ecologically sensitive areas. Agriculture is therefore a sector with potentially significant negative impacts on the environment, which may be exacerbated by the free trade mechanisms that facilitate its development.

The interaction between trade and the environment is amazingly imperative for nations whose economies depend intensely on farming. This can be particularly genuine when such exports are predetermined for markets in newly created nations. Natural concerns are by and large tall in newly created nations, and the request for more advantageous, safer, and more environmentally friendly products is becoming more pronounced (Laroche et al., 2001). The position offers considerable hurdles for Latin American and Caribbean nations whose primary export basis is agriculture. This necessitates a repositioning of agriculture based on a holistic view of development that integrates production-trade and ecological environmental components, as well as socio-cultural, human, and political institutional dimensions. The aim is for agricultural growth to be sustainable.

6.2 The Negative Impact of International Trade on the Environment

International commerce has a tremendous impact on the global economy, but it also has enormous environmental consequences. Global economic development has resulted in environmental concerns that transcend national borders and need international collaboration for successful solutions. This review will highlight some of the most important environmental challenges related to international commerce.

Deforestation and habitat destruction have been connected in many places to international commerce, notably in commodities such as lumber, soybeans, palm oil, and cattle. Demand for these items often encourages unsustainable logging methods, agricultural land clearing, and the loss of important habitat for endangered species (Pearce et al., 2003). This raise worries about biodiversity loss, ecological disturbance, and carbon dioxide emissions from deforested regions. Carbon emissions also contribute significantly to greenhouse gas emissions. Long-distance transportation of commodities by ships, aircraft, and trucks releases carbon dioxide and other pollutants. Furthermore, energy-intensive businesses such as manufacturing and production processes for traded products often depend on fossil fuels, increasing climate change. To reduce the effect of international commerce on global warming, the carbon footprint associated with it must be addressed.

Additionally, international commerce contributes to the exploitation and use of natural resources. Minerals, metals, fossil fuels, and water are all examples. Increased demand for these resources to fulfill global trade needs may lead to overexploitation, resource depletion, and ecological imbalance (Galli et al., 2015). Deep-sea mining and strip mining, for example, have substantial environmental impacts, including habitat loss and pollution. Pollution and waste generation are caused by the manufacture and transportation of commodities engaged in international commerce. Manufacturing, packing, and transportation processes often emit dangerous contaminants into the air, water, and soil. Improper waste management techniques, such as hazardous material disposal, may damage ecosystems and endanger human health. Plastic waste, a serious problem, is exacerbated by the packaging and transit of traded items.

Moreover, foreign trade has the potential to increase water scarcity and pollution, especially in water-stressed areas. Cotton, rice, and fruits, for example, need a significant amount of water for production. Water-intensive sectors like textiles and electronics contribute to water stress as well. Inadequate wastewater treatment and pollutant discharge from industrial operations may also pollute water bodies, impacting ecosystems and human populations (Anthony et al., 2007). By concentrating environmental responsibilities in disadvantaged places, international commerce may prolong environmental injustice. Industries trying to save costs and restrictions sometimes locate ecologically hazardous operations in nations with low environmental controls. This may lead to greater pollution and significant health consequences for vulnerable people living near industrial sites or traffic hubs.

These environmental issues need a comprehensive and coordinated approach. Trade agreements and multilateral environmental accords are two mechanisms that may be used to facilitate international cooperation in the enforcement of environmental standards, the promotion of sustainable practices, and the mitigation of the negative consequences of trade (Vogel, 1997). Traded goods may be guaranteed to meet certain environmental standards via the use of eco-labels, certification systems, and responsible sourcing initiatives. Some important methods and answers are as follows:

Promoting sustainable production and consumption is essential to lessening the negative effects of international commerce on the environment. This involves implementing measures to reduce pollution from manufacturing, lessen waste, and maximize efficiency using available materials. Positive change may be fueled by encouraging customers to choose sustainable goods and backing companies that use eco-friendly policies.

It is critical to ensure ethical and sustainable trade practices by implementing and enforcing international environmental norms and laws. In addition to international agreements and organizations, governments may play an important role in establishing and enforcing environmental norms. Investing in green technology and innovation may help lessen the toll that international commerce has on the planet (Hart & Milstein, 2003). Sustainable packaging options include supporting renewable energy sources and creating greener transportation networks. More environmentally responsible business dealings may result from funding research and development into environmentally friendly technology.

Consumers may learn more about the effect their purchases have on the environment if certification and labeling procedures are in place. Eco-labels, like the Forest Stewardship Council's (FSC) certification for lumber, provide buyers with more information with which to make purchasing decisions and promote ethical manufacturing. Waste production and depletion of natural resources may be reduced through the promotion of a circular economy strategy in international commerce. For this reason, it is important to design goods to last and be easily recycled, to promote the reuse and recycling of materials, and to cut down on the use of natural resources. (Thormark, 2001)

The importance of international collaboration and partnerships in resolving environmental concerns raised by international commerce cannot be overstated. Governments, corporations, CSOs, and citizens all need to work together and pool their expertise, experience, and resources for the greater good. The Paris Agreement on climate change is an example of a multilateral agreement that establishes a framework for international collaboration on environmental challenges. Deforestation, carbon emissions, resource depletion, pollution, water shortages, and environmental injustice are only some of the environmental difficulties posed by international commerce. To solve these problems, we need a comprehensive strategy that coordinates environmentally responsible production and consumption habits with strict environmental regulations, widespread use of eco-friendly technology, and increased international collaboration

(Moshood et al., 2022). We may work toward a more ecologically responsible and long-lasting international commerce system by adopting these measures.

6.3 Positive Impact of International Trade on the Environment

Globalization, economic expansion, and improved living standards have all been facilitated by global trade. It's normal to argue about how international commerce affects different sectors of society, but one area that's gotten a lot of attention is how it affects the natural world. Historically, increasing resource use, pollution, and greenhouse gas emissions have been cited as negative environmental repercussions of international commerce. A more detailed look indicates; however, the beneficial effects international commerce may have on the environment as well. Through analysis and illustration, this article will show how international commerce may aid in environmental sustainability and conservation.

Merchandise, services, cash, and technology are just a few of the things that may be traded internationally. There have been growing worries about how greater commerce can affect the environment. It has been argued that increased global commerce contributes to environmental problems such as pollution, deforestation, resource depletion, and ecological imbalances (Bokpin, 2017). While these are genuine worries, it's also important to remember that trade may lead to beneficial environmental effects as well.

Developments in Technology and Creative Breakthroughs fostered by international commerce may have profoundly beneficial effects on the natural world. Knowledge, technology, and best practices are often exchanged between nations via commerce. This collaboration encourages the development of green technologies. Cleaner and more efficient technology in fields such as renewable energy, waste management, and transportation has been propelled in large part by international cooperation and rivalry (Dunn, 2002). Environmental legislation and best practices may be shared across nations via international commerce. Agreements and procedures are often established when nations participate in commerce to guarantee adherence to environmental standards. This allows developing nations to implement and strengthen their environmental policies to satisfy the demands of international commerce. This method not only improves public health and safety, but it also aids the environment.

Maintaining biodiversity and supporting conservation initiatives may both benefit from international commerce. Countries may be encouraged to take better care of their natural resources and ecosystems by the economic benefits brought about through trade. Ecotourism, which depends on the responsible management of natural resources, may be promoted in nations with high levels of biodiversity by setting aside conservation areas and protected zones. Responsible environmental behavior may be encouraged through the trade of sustainably obtained items like certified lumber or organic agricultural goods. By encouraging environmentally friendly industrial techniques and ethical sourcing, foreign trade has the potential to green global supply chains. Sustainable goods are in more demand as customers become more aware of environmental issues (Kotler, 2011). To keep up with the changing tastes of their customers, companies throughout the world are beginning to implement more environmentally friendly policies. Therefore, businesses are under pressure to use less energy, produce less trash, and produce more sustainably.

When countries work together and take coordinated action to solve environmental problems, it's because of international trade. Climate change, deforestation, and pollution are global problems that cannot be solved by any one country alone (Carraro & Siniscalco, 1992). Countries are able to work together to solve these problems by exchanging information and working on solutions together in international organizations and via trade agreements. As an illustration of how international commerce may unite countries to address climate change, consider the Paris Agreement's pledge to cut GHG emissions.

While it is true that there are legitimate reasons to worry about the negative consequences of international commerce on the environment, it's just as important to remember that trade may also have good benefits. Sustainable development and conservation activities may benefit from international commerce by facilitating technical advancement, the transfer of environmental standards, the preservation of biodiversity, the greening of global supply chains, and cooperative efforts. To maximize the benefits of trade, policymakers and interested parties must collaborate.

CHAPTER 7 DATA AND METHOD

7.1 DATA

This study employs a comparative analytic methodology to explore the relationship between exchange openness, CO2 outflows, wage imbalance, renewable vitality, non-renewable vitality, and economic development in China and India. The research makes use of secondary time series data that were extracted separately for both nations from World Bank data from 1981 to 2020. In order to determine the affiliations between the factors, a set of statistical techniques like regression analysis and correlation analysis will be used to evaluate the data.

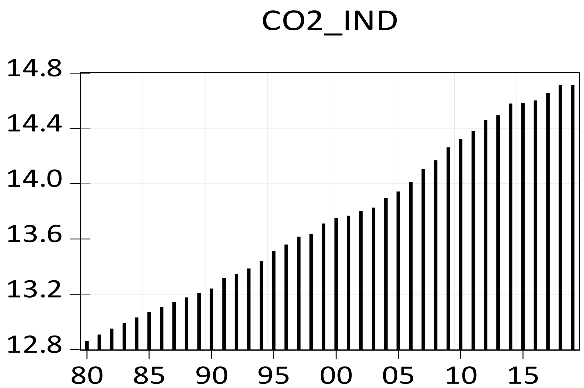
Table 2- Variables

Variables	Abbreviation	Unit of Measurement
Carbon dioxide Emission	CO2	Kilotons
Gross Domestic Product	GDP	Current US$
Renewable Energy Consumption	REC	% of total final energy consumption
Fossils Fuel Energy	FFE	% of total final energy consumption
Income Inequality	Gini	Gini index
Trade Liberation	TRA	% of GDP
Industrialization	IND	% of GDP (value added)
Population Growth	POP	% annual growth

This study employed eight variables to determine the genuine relationship between them, in contrast to earlier studies that only looked at two or three variables. The research focuses on the examination of the relationship between natural and macroeconomic variables in China and India using a range of econometric time series approaches. The study assumes that the various variables in another study (Jayanthakumaran et al., 2012), which was modified for the example of these nations, have a linear relationship with one another. The relationship between energy utilization, economic yield, and environmental disintegration is well known; government agencies and other groups have studied how these factors affect climate change and ecological disruption. According to a Royal Society assessment (Connor et al., 2021), rising energy use is causing problems like carbon dioxide emissions and is diminishing the planet's resources. This is why the factors in the current study pertain to carbon dioxide emissions, energy use, and economic performance. Some policymakers think that public and private investment can increase productivity and improve economic performance. Investments can stimulate the adoption of new technologies and produce advantageous externalities in addition to providing capital funding. The current study's foundation is based on this concept.

Private investment is essential for generating jobs and fostering economic growth, and capital inflow is advantageous for the economy. However, this emphasis on economic growth could lead to the neglect of environmental laws to entice investment, creating a "pollution heaven" situation where both the public and private sectors put cost-cutting tactics ahead of environmental considerations. The current study's inclusion of the investment variable was motivated by this worry. International institutions like the World Trade Organization (WTO) and the International Trade Centre have acknowledged the connection between trade and the environment and have proposed programs on trade, the environment, and natural resource management to support sustainable development. Increased energy use and economic activity brought on by trade may result in higher carbon dioxide emissions (Farhani, Chaibi, & Rault, 2014). The population variable is also taken into consideration because growing populations might result in higher energy demands, which can raise carbon dioxide emissions and cause deforestation (Shi, 2001). The variables in the model are graphically depicted in Figure 5.

7.1.1. Time Series Graphs


CO2_IND
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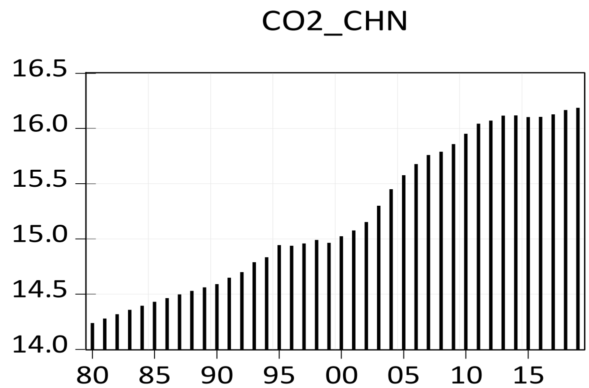
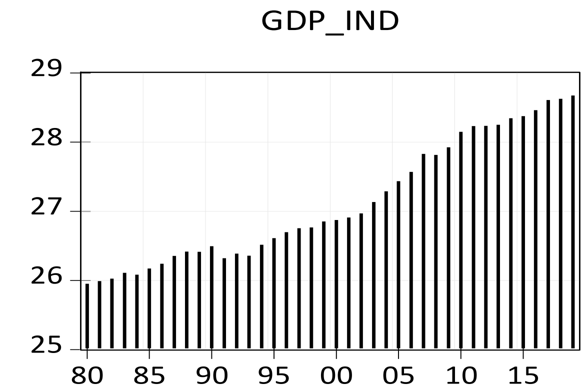
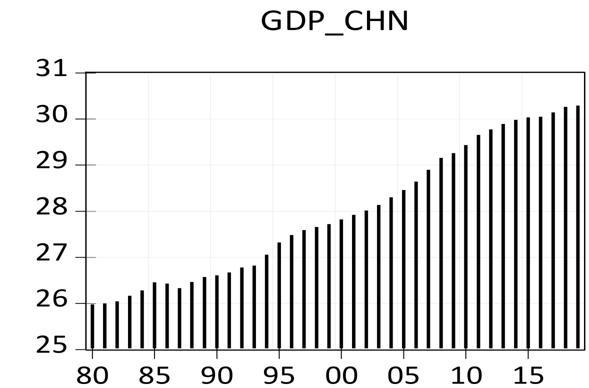
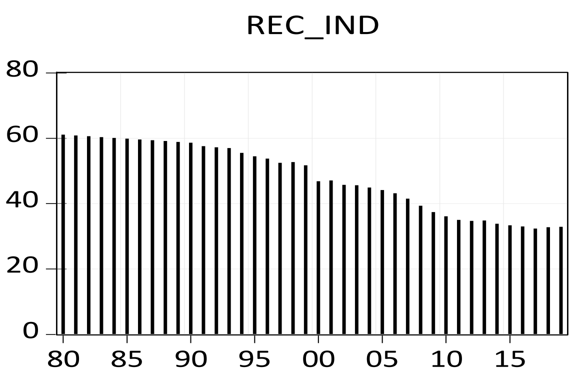
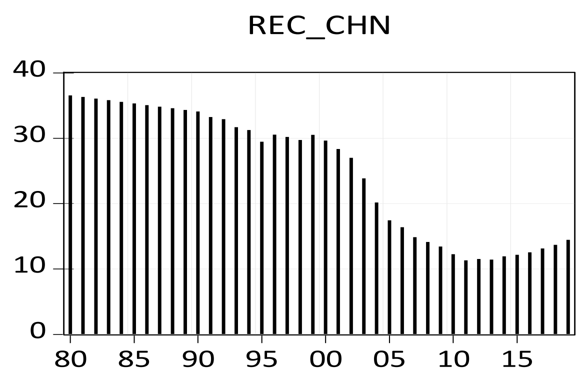
14.4
14.0
13.6
13.2
12.8
80 85 90 95 00 05 10 15

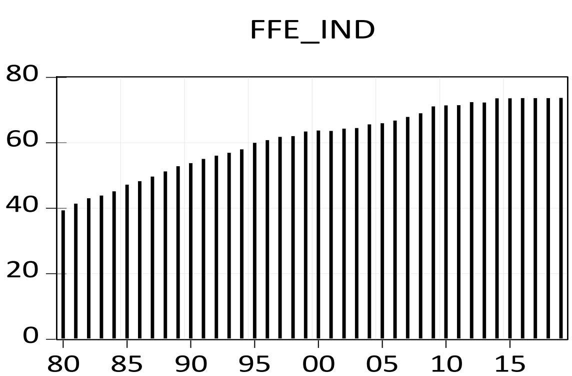

CO2_CHN
16.5
16.0
15.5
15.0
14.5
14.0
80 85 90 95 00 05 10 15

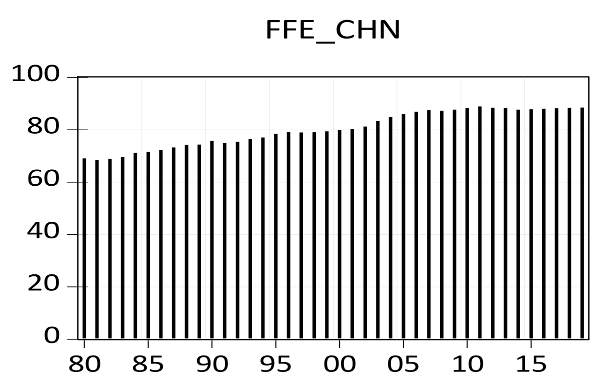

GDP_IND
29
28
27
26
25
80 85 90 95 00 05 10 15


GDP_CHN
31
30
29
28
27
26
25
80 85 90 95 00 05 10 15


REC_IND
80
60
40
20
0
80 85 90 95 00 05 10 15


REC_CHN
40
30
20
10
0
80 85 90 95 00 05 10 15


FFE_IND
80
60
40
20
0
80 85 90 95 00 05 10 15


FFE_CHN
100
80
60
40
20
0
80 85 90 95 00 05 10 15

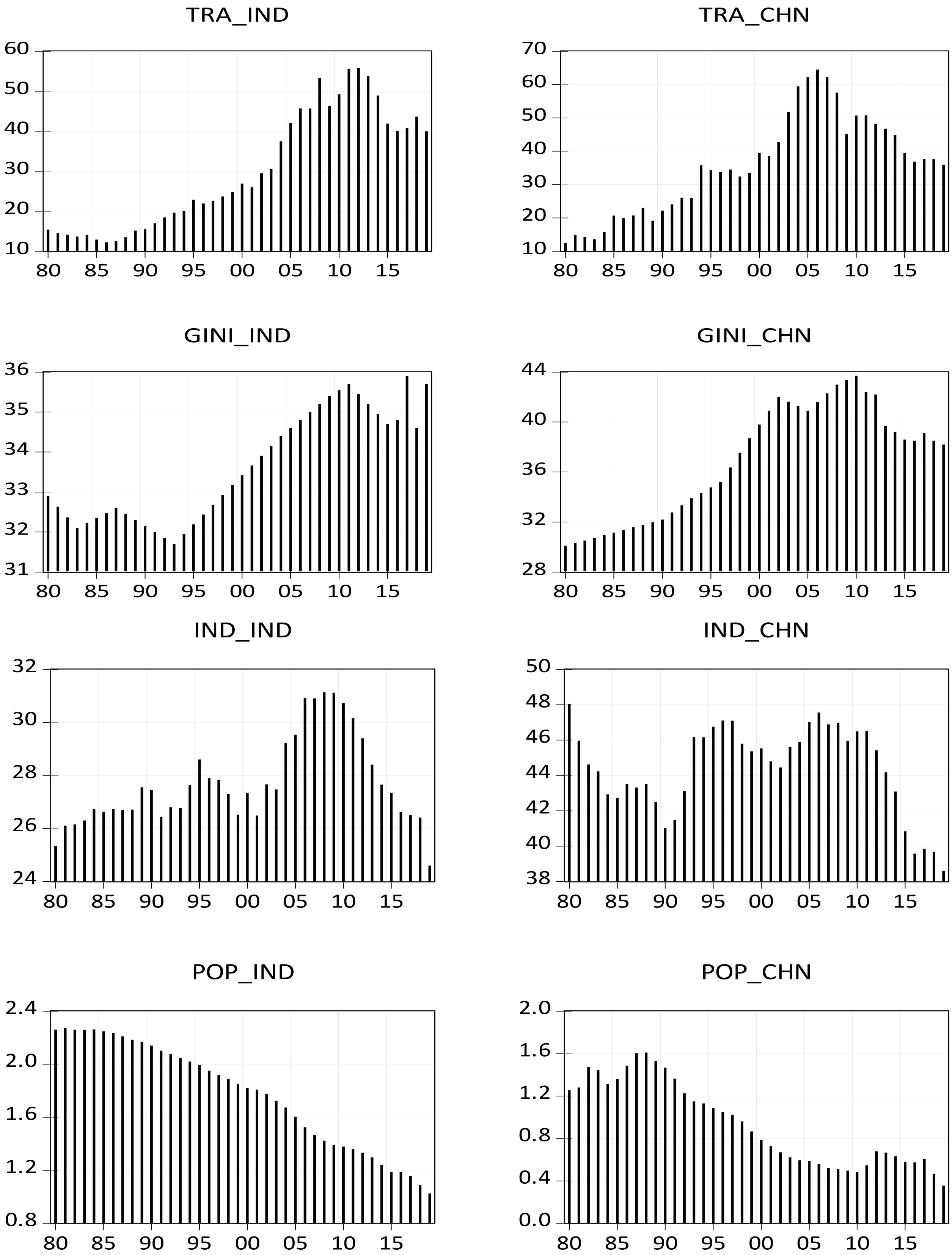


Figure 5: Time Series graphs of India and China

Table 3 Descriptive statistic India

Variable	LCO2	LGDP	REC	FFE	GINI	TRA	IND	POP
Mean	13.75662	27.12962	48.15697	61.04961	33.61375	29.94969	27.69573	1.770411
Median	13.73149	26.86225	49.41365	63.55418	33.29545	25.40443	27.33661	1.835759
Max	14.71417	28.67185	61.09510	73.67543	35.90000	55.79372	31.13672	2.275893
Min	12.86262	25.95076	32.41000	39.38335	31.70000	12.21927	24.59646	1.025311
SD	0.584557	0.893446	10.48548	10.46430	1.372413	14.65967	1.659456	0.403540
Sk.	0.180997	0.400792	-0.239347	-0.493029	0.216111	0.359165	0.772002	-0.304450
Kur	1.756007	1.690524	1.499065	2.082424	1.482562	1.651672	2.768453	1.694466
J.B	2.797597	3.928774	4.136586	3.023759	4.149060	3.889976	4.062603	3.458634
Prob.	0.246893	0.140242	0.126401	0.220495	0.125615	0.142989	0.131165	0.177406
Sum	550.2647	1085.185	1926.279	2441.984	1344.550	1197.988	1107.829	70.81644
SS	13.32656	31.13160	4287.870	4270.559	73.45720	8381.326	107.3980	6.350944
Obs.	40	40	40	40	40	40	40	40

Source: Author`s estimation

Table 4 Descriptive statistic China

Variable	LCO2	LGDP	REC	FFE	GINI	TRA	IND	POP
Mean	15.20219	27.96471	24.94891	80.33481	36.91000	35.73692	44.41041	0.933687
Median	15.00668	27.77181	29.55106	79.62068	38.35000	35.82996	45.07664	0.826904
Max	16.18643	30.28988	36.56198	88.89836	43.70000	64.47888	48.05769	1.610071
Min	14.23737	25.97632	11.34000	68.38125	30.10000	12.42485	38.58741	0.354741
SD	0.672334	1.449567	9.679507	6.896278	4.516350	14.78424	2.478554	0.392358
Sk.	0.184088	0.237378	-0.282159	-0.204685	-0.125896	0.217775	-0.702982	0.308237
Kur	1.532428	1.645890	1.352115	1.648723	1.528632	2.131563	2.540146	1.596084
J.B.	3.815536	3.431675	5.056635	3.322554	3.713870	1.573144	3.647001	3.918367
Prob.	0.148411	0.179813	0.079793	0.189896	0.156150	0.455403	0.161460	0.140973
Sum	608.0875	1118.588	997.9565	3213.392	1476.400	1429.477	1776.416	37.34746
SS	17.62927	81.94851	3654.021	1854.787	795.4992	8524.377	239.5859	6.003853
Obs.	40	40	40	40	40	40	40	40

Source: Author`s estimation

A descriptive analysis is performed on the collected data. Tables 3 and 4 provide the metrics of central tendency, dispersion, and normality. A metric of central tendency is the mean, which represents the average value of a dataset. It is calculated by adding up all the values in the dataset and then dividing the total number of values. According to the descriptive table under the central tendency measurements, China is the world's top carbon emitter. Because of its larger economic activities and population, China's carbon emissions are currently far higher than India's. The mean data clearly reveal that China emits more carbon emissions (15.20219) than India (13.75662). However, as its economy grows, India's emissions are rapidly increasing, causing substantial environmental challenges. These variables are directly related to fossil fuels. Both countries rely heavily on fossil fuels to meet their energy demands. While India is more reliant on oil and gas, China has historically been the world's largest coal consumer. China holds 80% of the world's fossil fuel reserves, while India holds 61%. Conversely, renewable energy reduces CO2 emissions. Both countries are investing heavily in renewable energy to reduce their dependence on fossil fuels. India has ambitious ambitions to increase its renewable energy production, while China is now the world's largest producer of solar energy. The average use of renewable energy in India is 48%, while in China it is only 25%. Both countries are also investigating technologies such as wind, hydro, and biomass to boost clean energy generation. China's GDP is the second largest in the world after the United States and ahead of India. China has a logarithmic mean value of 27.96471, while India has a value of 27.12962. However, India's GDP is growing faster than China's, with a forecast growth rate of. Although China outnumbers India in terms of population, the two countries have similar populations. However, India's population growth rate is about 1.8% on average, while China's is less than 1%. As a result, India is expected to overtake China as the world's most populous country in the near future. The Gini coefficient is a statistical measure of inequality in the distribution of income or wealth in a country. India's average Gini coefficient is 33.6%, lower than the 36.9% in China. This indicates that India's income is more evenly distributed among its people than China's. China leads the world in trade liberalization and industrialization by a wide margin. Economic activities often involve the establishment of industrial facilities as well as the adoption of new technology and manufacturing methods. Industrialization can result in employment creation, increased productivity, and economic expansion. The median, a measure of central tendency, represents the center value in a dataset. When working with skewed or outlier-prone data, it is useful to describe the typical value or range of values in a dataset. After organizing the dataset from lowest to highest to establish the median, the center value (or average of the two center values, on the off chance that there are an even number of values) is picked.

The standard deviation is a degree of dispersion that represents the average amount by which each item in a dataset deviate from the mean. It is a useful technique for detecting outliers and describing the range of values in a dataset. A higher standard deviation indicates a wider range of values, whereas a lower standard deviation indicates a closer clustering of the data around the mean. According to the statistics above, population growth has the shortest standard deviation for both countries, followed by CO2 emissions and GDP, while trade liberation, renewable energy, and fossil fuels have the greatest for both countries.

The dataset's range is represented by the highest and lowest values. Because the original data has been changed to a log format, the maximum and minimum values of CO2 emissions and GDP cannot be correctly determined. Except for renewable energy and fossil fuels, which have a wide range in both countries due to their transition, all other variables have a narrow range.

Skewness, kurtosis, and Jarque Bera are normal measures. Skewness and kurtosis are markers of a probability distribution's form, and the Jarque-Bera test is a statistical approach utilized to decide whether a dispersion is ordinary.

Skewness is a distribution metric that measures asymmetry. In contrast to a negative skewness distribution, which contains a tail that expands to the left and the bulk of values assembled to the right of the top, a positive skewness distribution contains a tail that expands to the right. Carbon emissions, GDP, renewable energy, fossil fuels, and trade liberation all have comparable statistical skews. CO2 emissions, GDP, and trade liberation are positively biased in both countries, whereas renewable energy and fossil fuels are negatively skewed. The Gini coefficient is skewed in favor of India and against China. The last two variables swap the skewness patterns of the two countries.

Kurtosis is a measure of how much the tails of a probability distribution deviate from the normal distribution. Compared to the normal distribution, a positive kurtosis distribution has heavier tails and a sharper peak, while a negative kurtosis distribution has lighter tails and a flatter peak. All variables have flat (flat) distributions. The Jarque-Bera test derives a test statistic from the skewness and kurtosis of a dataset and compares it to the predicted distribution of the test statistic under normality. If the test statistic is greater than the critical value, the null hypothesis of normality is rejected, indicating that the data set is not normally distributed.

7.2 Methods

This study utilizes quantitative analysis through the application of econometric modeling to make economic inferences. The primary methods of analysis and estimation are bound testing, causality, and regression. The econometric modeling will rely on various test analyses and diagnoses, such as bound, ADF, unit root tests, regression, serial correlation, and causality. Depending on the results of the unit root and connection tests, the study chooses one of the regression analysis techniques, such as the generalized method of moments, the ordinary least squares method, or the autoregressive distribution lag. (Dickey & Fuller, 1979)

7.2.1 Augmented Dickey fuller Unit Root

Assessing the stationarity of variables, the Augmented Dickey-Fuller (ADF) test is a statistical hypothesis test. This determines if the time series has a unit root or if it is stationary (Dickey & Fuller, 1979). If the test statistic is less than the critical value derived from the table or determined through simulation, the null hypothesis is rejected, indicating that the time series is stationary. To prevent spurious regression results, it is important to examine the stationarity order. The Dickey matrix, derived from Dickey & Fuller (1979) was used to test single roots and provide the following definitions:

Ho = time series has unit root

$\mathrm{Yt} = \beta \mathrm{Yt} - 1 + \mu \mathrm{t}$ .... (1)

When β = 1, It indicates an issue with the unit root or the non-stationarity of the series. If 1, however, we can conclude that the series is stationary. T-testing the hypothesis that = 1 with the above equation would produce biased results. For a solution to this, both sides of the equation can be subtracted by Yt-1.

$\mathrm{Yt} - \mathrm{Yt} - 1 = \beta \mathrm{Yt} - 1 - \mathrm{Yt} - 1 + \mu \mathrm{t} = (\beta - 1)\mathrm{Yt} - 1 + \mu \mathrm{t}$ … … … … … … . (2)

$\Delta \mathrm{Y} = \Theta \mathrm{Yt} - 1 + \mu \mathrm{t}$ ……………………………….. (3)

Where *Ɵ* is the same as *(β-1)* so for each time series the hypothesis is.

The ADF is also efficient because it allows for serially correlated error term μ_t.

$\Delta \mathrm{Y} = \beta 1 + \beta 2\mathrm{t} + \Theta \mathrm{Yt} - 1 + \Sigma \alpha \mathrm{i}\, \Delta \mathrm{Yt} - 1 + \mu \mathrm{t}$ ---------------------------------- (4)

The t-statistic adjusted for trend considers the lagged dependent variable coefficient in the regression equation and adjusts it for any drift or trend. The standard error is calculated using the normal methods for regression analysis.

7.2.2 Phillips Peron Unit root test

This test is a modified variant of the Dickey-Fuller test that accounts for error autocorrelation and estimates the test statistic using a non-parametric technique. The test statistic's formula is comparable to that of the ADF test, but it makes use of a different variance estimator. When Phillips and Peron developed this technique in 1988, the study of economic time series soon adopted it. The Phillips-Peron (PP) test and the ADF test differ significantly in how serial correlation and error covariance are handled. While the PP test eliminates serial correlation in the regression test, the ADF test uses standardized auto regression to estimate the ARMA method of the regression error of the test.

$\Delta Yt = \beta o Xt + \pi Yt - 1 + \mu t$ ……………………. (5)

Any serial correlation and heteroscedasticity in the test regression's errors are taken into account by the PP tests.

7.2.3 Econometric Model

$$C02_t = \beta_0 + \beta_1 GDP_t + \beta_2 REC_t + \beta_3 FFE_t + \beta_4 TRA_t + \beta_5 GINI_t + \beta_6 IND_t + \beta_7 POP + \mu_t \dots\dots\dots\dots\dots\dots\dots.\dots (6)$$

β_0= Intersection of the ratio in the model/constant

$\beta_1 - \beta_5$= Coefficients of the exogenous variable.

μ = Stochastic variable (error term)

t = Time series data

To eliminate heteroscedasticity and determine the rate of rise of significant variables, all variables were logarithmically converted. Using the necessary logarithms from Equation all variables were log transformed except CO2 emissions ad GDP.

$$LNC02_t = \beta_0 + \beta_1 LNGDP_t + \beta_2 REC_t + \beta_3 FFE_t + \beta_4 TRA_t + \beta_5 GINI_t + \beta_6 IND_t + \beta_7 POP + \mu_t \dots\dots\dots\dots\dots\dots\dots.\dots (7)$$

7.2.4 Auto Regressive Distribution Lag (ARDL)

This model incorporates latent variable values as explanatory variables, in addition to current values and regression models. Unlike the VAR model, which is primarily designed for endogenous variables, the ARDL model is suitable for both exogenous and endogenous variables. It is particularly useful when variables are integrated at order 0 and 1 only; if variables are integrated at higher orders, the model can produce misleading results. The bound test results help determine whether to specify the model for long- or short-term regression. If variables are co-integrated, the long-run ARDL, which is like the error correction model, is appropriate. One advantage of the ARDL model is that its results are considered unbiased.

To evaluate the associations between the variables in Equation 7 for this inquiry, we used constrained ARDL approaches. ARDL models are finite element models that incorporate new variables into their calculations. Concrete and precise short-term results are achieved (Ghosh 2009). The ARDL method should be used to determine this error correction rate. The model is generally expressed as follows:

$$\Delta LNC02_t = \alpha_0 + \sum_{i=1} \alpha_1 \Delta GDP_{t-1} + \sum_{i=1} a_2 \Delta REC_{t-1} + \sum_{i=1} a_3 \Delta FFE_{t-1} + \sum_{i=1} a_5 \Delta GINI_{t-1} + \sum_{i=1} \alpha_6 \Delta IND_{t-1} + \sum_{i=1} a_7 \Delta POP_{t-1} + \beta_1 LNC02_{t-1} + \beta_2 LNGDP_{t-1} + \beta_3 REC_{t-1} + \beta_4 FFE_{t-1} + \beta_5 TRA_{t-1} + \beta_6 GINI_{t-1} + \beta_7 IND_{t-1} + \beta_8 POPO_{t-1} + \mu_{t-1} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots..(8)$$

7.2.5 ARDL Bounds Testing Approach to Cointegration and Granger Causality

After determining the presence or absence of a unit root in time series analysis, it is important to determine whether the variables are in long-term, short-term, or equilibrium relationships. Analysis of relationships between variables using the ARDL limit test method. ARDL models are dynamic specifications that consider both delayed and simultaneous values of the explanatory variables and delayed values of the dependent variable. This makes it possible to directly assess short-term impacts and indirectly estimate long-term equilibrium proportions (Altinay, 2007). The ARDL method requires estimation of an unconstrained error correction model.

After analysing long-term relationships between variables, the 1969 Granger test of causality determines whether variables are causative of each other in the short term. The Granger causality test is a statistical technique for determining whether one time series can predict another. To determine causality between two time series, this test examines whether past values of one time series have a significant impact on current values of the other time series. This test involves estimating and comparing the residuals of two regression models. One has lag values for both the dependent and independent variables, and the other has lag values for the dependent variable only. If the residual sum of squares for the first model is small, the independent variable Granger is said to be responsible for the dependent variable. Alternatively, indicate the unidirectional or bidirectional flow of causality in each analysis.

$$\Delta LNC02_t = \alpha_0 + \sum_{i=1} \alpha_1 \Delta GDP_{t-1} + \sum_{i=1} a_2 \Delta REC_{t-1} + \sum_{i=1} a_3 \Delta FFE_{t-1} + \\ + \sum_{i=1} \alpha_4 \Delta TRA_{t-1} + \sum_{i=1} a_5 \Delta GINI_{t-1} + \sum_{i=1} a_6 \Delta IND_{t-1} + \\ \sum_{i=1} a_7 \Delta POP_{t-1} + \theta ECT_{t-1} + \mu_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.\ldots\ldots (9)$$

Here is Error Correction Term (ECT) based on long-term relationships. The F-statistic of the regressors ECM indicates that the short-term main effects are significant. Interrupted ECT scale t-statistics demonstrated a significant length main effect.

If the error term is integrated that order (0) then it can be said there is co integration within variable. is the cointegration parameter and it is said that if variables are set to be co integrated, then they can be use and interpreted for long run analysis. In establishing causality, we must make sure that the underlining variables are stationary. Cointegration occurs when the linear combination of two or more nonconstant series is constant. Cointegration testing is required to determine if one is empirically modelling significant relationships.

CHAPTER 8 RESULTS AND DISCUSSION

8.1 Introduction

This section of the research work includes empirical findings from all methods of analysis. The pre-analysis test results include the traditional unit root test (ADF and PP) as well as a co-integration test such as the ARDL bound test. The post-analysis test depicts the level of stability and variable specification in the model. The CUSUM and CUSUM of Squares tests are used in this case. To make an accurate comparison, we analyze each country separately and compare the results.

8.2 Unit Root result of China and India

Time series data are unreliable in terms of stationarity. Before using the model to make predictions, it is important to determine the degree of stationarity of the variables. Unit root tests are useful for detecting and stabilizing trends in temporal variables. An extended unit root test by Dickey-Fuller (ADF) and Philip Perons (PP) was used. It is assumed that the series has unifying roots. The unit root test results show that the level of integration of the variables is the same for both the ADF and PP tests. Renewable energy, fossil fuels, and population growth are integrated at order zero (0), which means they have no unit root problems. Other variables like CO2 emissions, GDP, income inequality, trade, and industrialization are all stable at first. This result holds true for both ADF and PP in India. For China, the results are mixed and inconsistent. All the variables are not stable at level I(1) for the ADF test, and the null is completely rejected except for income inequality, which has a stable trend at level. The PP shows fossil fuel is stable with no trend at level, while all other variables only become stable after the first difference. So it is a mixture of I(0) and I(1). In such cases, it is crucial to choose a model that will give us the correct findings. Omission bias and serial correlation in the residuals are no longer problems with the ARDL approach, which also performs well for small sample sizes (Pesaran 1997)

8.3 Bound test results of China and India.

After completing the stationarity tests for both method tests in Tables 5 and 6 above, models were selected based on previous results. Long-term associations between variables were shown using the ARDL combination test instead of the cointegration test (Peseran et al. 2001). The existence of long-term associations between variables is assessed using the ARDL (autoregressive variance lag) marginal test. The table in this case shows the results of ARDL-related tests for China and India separately.

Table 5: Unit Root of India

Variables	Augmented Dickey Fuller (ADF)		Philip Perrons (PP)	
	Level	1st Difference	Level	1st Difference
LCO2	0.9886	0.0001***	0.9835	0.0000***
LGDP	0.9956	0.0000***	0.9947	0.0000***
REC	0.0000***		0.0004***	
FFE	0.0002***		0.0001***	
TRA	0.7930	0.0001***	0.7681	0.0001***
GINI	0.7816	0.0303**	0.9039	0.0000***
IND	0.4668	0.0312**	0.4673	0.0001***
POP	0.0600*		0.0001***	

Source: Author`s estimation
Note: *, ** and specify the significance of variables at 10%, 5% and 1% respectively**

Table 6: Unit Root of China

Variables	Augmented Dickey Fuller (ADF)		Philip Perrons (PP)	
	Level	1st Difference	Level	1st Difference
LCO2	0.8829	0.0362**	0.9253	0.0280**
LGDP	0.9511	0.0077***	0.9886	0.0065***
REC	0.7267	0.0181**	0.0349**	
FFE	0.5447	0.0005***	0.6093	0.0004***
TRA	0.4667	0.0002***	0.4505	0.0002***
GINI	0.0171**		0.5254	0.0138**
IND	0.6723	0.0033***	0.9253	0.0032***
POP	0.8845	0.0094***	0.9886	0.0164**

Source: Author`s estimation
Note: *, ** and specify the significance of variables at 10%, 5% and 1% respectively**

Table 7: Bound Test India

Test Statistics	Value	Significance	I(0)	I(1)
F-statistic	49.14586	10%	1.92	2.89
K	7	5%	2.17	3.21
		2.5%	2.43	3.51
		1%	2.73	3.9

Source: Author`s estimation

Table 8: Bound Test China

Test Statistics	Value	Significance	I(0)	I(1)

F-statistic	39.36796	10%	1.92	2.89
K	7	5%	2.17	3.21
		2.5%	2.43	3.51
		1%	2.73	3.9

Source: Author`s estimation

The F-statistic values for India show 49.14586, while those for China show 39.36796. These numbers reflect the test's overall relevance. The crucial values are offered at several levels (10%, 5%, 2.5%, and 1%), allowing their relevance to be evaluated. If the value of the F-statistic is above the critical value at a certain level of significance, then there is a long-term association between the variable (variable) and I(1) (the lag variable) at 10 critical values each; the percent significance levels are 1.92 and 2.89. Comparing the F-statistic values to the appropriate critical values can help you understand the results. If the F statistic is greater than a critical value at a certain level of significance, this indicates that the variables under study have a long-term association in a particular country.

The decision rule states that if the F statistic is less than 5% of the upper and lower bounds, there is no significant relationship between the variables. According to tables 9 and 10, it is confirmed that the F-statistics for both countries are greater than 5% of the threshold for upper and lower bounds. This demonstrates that, at 10%, 5%, and 1% significance levels, there's a long affiliation between the subordinate variable and the regressors.

8.4 Short-run ARDL and ECM results for India and China

ARDL (Autoregressive Distributed Lag) is a popular econometric technique for analyzing the short- and long-term dynamics of time series data. In the short term, the ARDL model captures the effects of current and past variable values on the dependent variable. A short-term ARDL model consists of lag values for the dependent and explanatory variables. The lag variable coefficient represents the short-term dynamics. A bounds-testing approach can be used to estimate short-term ARDL models. This provides an accurate method of assessing the existence of long-term relationships between variables. Boundary test methods consider both the significance and stability of the estimated coefficients (Pesaran et al., 2001). Estimating the ARDL short-run model entails determining the model's lag order, determining the appropriate lag length, and performing diagnostic tests for model adequacy, such as autocorrelation and heteroscedasticity.

In applied econometrics, ARDL short-run models are commonly used to analyze the short-term dynamics of various economic phenomena, such as the impact of monetary policy on output, the effect of exchange rate changes on trade, or the relationship between government spending and economic growth.

The coefficients from the ARDL short-run estimations provide insights on how the variables relate to each other in Tables 11 and 12 of the two nations. The variable elasticities of India are all significant, while trade openness and industrialization are not for China. A percentage change in each of GDP, fossil fuels, and trade openness in India led to an increase of 0.139174, 0.011431, and 0.002290 percent, respectively, in CO2 emissions, holding other variables constant with significant p-values, which agrees with Y. Chen et al. (2019), (2015). In China, a percentage change in GDP and fossil fuels would increase CO2 emissions by 0.120821 percent and 0.023532 percent, respectively, assuming other variables remain constant. There is a positive correlation between industrialization and CO2 emissions in China, but this is not significant.

The relationships between renewable energy, income inequality, and population growth and carbon emissions in both nations are negative and statistically significant, which also agrees with Chen et al. (2019). If any of these variables (renewable energy, income inequality, and population growth) increase by a percentage in India, carbon emissions will decrease by 0.009479, 0.026132, and 0.199427, respectively, with the assumption that other variables stay constant. A similar outcome is also true for the case of China: if each of the variables listed in parenthesis increases by a percentage, carbon emissions will decrease by 0.018213, 0.010556, and 0.081847 percent; other variables are constant.

Table 9. Short run ARDL and ECM of India. (DV C02 Emission)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LCO2(-1)	0.305148	0.147224	2.072674	0.0469**
LGDP	0.139174	0.037192	3.742051	0.0008***
REC	-0.009479	0.003483	-2.721137	0.0107**
FFE	0.011431	0.002658	4.300184	0.0002***
GINI	-0.026132	0.008794	-2.971499	0.0058***
TRA	0.002290	0.000941	2.432729	0.0212**
IND	-0.013843	0.005548	-2.495178	0.0183**
POP	-0.199427	0.082268	-2.424128	0.0216**
C	7.102628	1.790872	3.966017	0.0004***
CointEq(-1)*	-0.694852	0.029356	-23.66987	0.0000***

Source: Author`s estimation
Note: *, ** and specify the significance of variables at 10%, 5% and 1% respectively**

Table 10. Short run ARDL and ECM of China. (DV C02 Emission)

Variables	Coefficient	Std. Error	t-Statistic	Prob.*
LCO2(-1)	0.268349	0.137642	1.949614	0.0606*
LGDP	0.120821	0.048821	2.474766	0.0192**
REC	-0.018213	0.002912	-6.255250	0.0000***
FFE	0.023532	0.005426	4.336741	0.0002***
GINII	-0.010556	0.003461	-3.049963	0.0048***
TRA	-0.000556	0.001054	-0.527849	0.6015
IND	0.000466	0.002523	0.184834	0.8546
POP	-0.081847	0.037754	-2.167923	0.0382**
C	6.787878	0.917366	7.399317	0.0000***
CointEq(-1)*	-0.731651	0.034537	-21.18478	0.0000***

Source: Author`s estimation
Note: *, ** and specify the significance of variables at 10%, 5% and 1% respectively**

Table 11. Estimated long run ARDL coefficients of India (DV C02 Emission.)

Variables	Coefficient	Std. Error	t-Statistic	Prob.*
GDP	0.200293	0.035712	5.608499	0.0000***
REC	-0.013641	0.003573	-3.817593	0.0006***
FFE	0.016451	0.001545	10.65020	0.0000***
GINI	-0.037608	0.010603	-3.546930	0.0013***
TRA	0.003296	0.001346	2.448481	0.0204**
IND	-0.019922	0.005410	-3.682686	0.0009***
POP	-0.287007	0.104136	-2.756084	0.0099***
C	10.22178	1.215573	8.409024	0.0000***

Source: Author`s estimation
Note: *, ** and specify the significance of variables at 10%, 5% and 1% respectively**

$$LNC02_t = 10.22178 + 0.200293LNGDP - 0.013641REC + 0.016451FFE + 0.003296TRA - 0.037608GINI - 0.019922IND - 0.287007POP + \mu_t \dots\dots\dots\dots\dots\dots\dots.\dots (10)$$

Table 12. Estimated Long run ARDL Coefficients of China. (DV C02 Emission.)

Variables	Coefficient	Std. Error	t-Statistic	Prob.*
GDP	0.165134	0.042024	3.929521	0.0005***
REC	-0.024893	0.003035	-8.200979	0.0000***
FFE	0.032163	0.006422	5.008009	0.0000***
TRA	-0.000760	0.001421	-0.535119	0.5965
GINI	-0.014428	0.004010	-3.597972	0.0011***

IND	0.000637	0.003408	0.186983	0.8529
POP	-0.111866	0.059148	-1.891287	0.0683*
C	9.277475	1.078561	8.601718	0.0000***

Source: Author`s estimation
Note: *, ** and specify the significance of variables at 10%, 5% and 1% respectively**

$$LNC02_t = 9.277475 + 0.165134LNGDP - 0.024893REC + 0.032163FFE - 0.000760TRA - 0.014428GINI + 0.000637IND - 0.111866POP + \mu_t \dots\dots\dots\dots\dots\dots\dots.\dots (11)$$

Comparing tables 9 and 10, we can observe that there are more similarities between the two nations than differences. When assessing the first lag of the dependent variable, both of them have positive elasticities with significant p-values. The coefficient of the intercept is also positive, with a high level of significance below 1%. The intercepts for India and China are 7.102628 and 6.787878, respectively, and they represent the values of carbon emissions when all the independent variables are held constant. GDP and fossil fuels are positively correlated and have a large short-term impact on both countries' carbon emissions. Trade openness failed to show a positive trend with C02 emissions in India, which is true for India but not significant in all cases. In addition, industrialization has a significant impact on CO2 emissions in India and China. Based on the estimation results, it was found that there is a positive correlation between production (growth) and CO2 emissions in both countries. On the other hand, there is a statistically significant negative correlation between renewable energy, income inequality, population growth, and CO2 emissions. The introduction of renewable energy and trying to level the income distribution in these countries could reduce the high amount of carbon pollution.

Error correction models (ECMs) integrate short-term dynamics and long-term equilibria in time series analysis. This includes the concept of cointegration, which means that variables have a long-term relationship. It also includes lagged values of the dependent and explanatory variables to capture the process of adjusting to equilibrium over time. It also helps to understand the rate of adjustment towards long-term equilibrium and provides insight into short-term dynamics. The integral equations in Tables 9 and 10 also show the correction of variables due to prior period imbalances. Critical error correction conditions indicate adjustments that occur and maintain long-term relationships over the long term. The VECM results show that all environmental variables are adjusted to maintain the long-term equilibrium of Eq. (1) with significant p-values.

8.5 Long-run estimation results for India and China

Long-term estimates of ARDL are used to study the long-term dynamics of variables, considering their relationships. Long-term estimation of autoregressive variance-lag (ARDL) models requires consideration of relationships between variables over time. To capture long-term equilibrium, the model can include lagged dependent and independent variables. Estimating long-term ARDL models involves performing a limit-testing procedure to determine the existence of long-term relationships between variables. This procedure evaluates the importance and stability of the estimated coefficients. Long-run equilibrium can be interpreted based on the sign and statistical significance of these coefficients (Pesaran et al., 2001). Quantify the long-term effect of changes in the independent variable on the dependent variable by estimating the long-term coefficient. The ARDL long-run model allows researchers to examine important economic relationships by capturing long-run dynamics. It provides insights into the variables' persistent and stable relationships, which is useful for understanding long-run dynamics and making long-term policy recommendations.

The results of the long run demonstrate a similar outcome to that of the short run. Variables that are positively and negatively related to the two nations in the short run show the same outcome in the long run. The dissimilarity is the coefficient of elasticity at which the change in one impacts the other. India also has significant variable elasticities in all variables, while China does not for trade openness and industrialization. A percentage increase in any of GDP, fossil fuels, or trade openness increases CO_2 emissions by 0.200293, 0.016451, and 0.003296 percent, respectively, in India, with significant p-values in agreement with Ohlan (2015). GDP and fossil fuel percentage changes in China will also increase CO_2 emissions by 0.165134 and 0.032163 percent, respectively, assuming other variables remain constant. Many economic activities that are taking place in these two developing nations cause pollution. Industrialization in China increases carbon emissions, but not significantly.

Carbon emissions in India will decrease by 0.013641, 0.037608, 0.019922, and 0.111866 percent if renewable energy, income inequality, industrialization, and population growth each increase by one percentage point, assuming all other factors remain the same. This result agrees with Yang et al. (2020). Carbon emissions in China would also decrease by 0.024893, 0.014428, and 0.111866 if the variables above were increased by one percent (assuming all other variables remained the same). The growing population and introduction of modern energy supplies in these countries help reduce emissions.

8.6 Results of Diagnostic Tests in India and China.

Regression analysis requires residual diagnostics to evaluate a model's quality and suitability. It involves analyzing residuals and the differences between observed and anticipated values. The residuals must have normality (a bell-shaped distribution), homoscedasticity (constant variance), and independence (no correlation or patterns) to be valid. Researchers can identify violations of these assumptions and potential problems like outliers or influential data points by examining the residuals using residual plots, histograms, and statistical tests. Residual diagnostics ensure the regression model's reliability and validity by providing insights for model refinement and identifying areas where the model may be inadequate.

Table 13: Diagnostic Test India

Test	F-Statistics	Probability	Result
Serial Correlation	0.049508	0.9336	No serial correlation
Normality	1.552137	0.4602	Normally distributed
Heteroscedasticity	1.245859	0.9334	Homoscedasticity

Source: Author`s estimation

Table 14: Diagnostic Test China

Test	F-Statistics	Probability	Result
Serial Correlation	2.750395	0.0812	No serial correlation
Normality	1.705722	0.4262	Normally distributed
Heteroscedasticity	0.901131	0.9345	Homoscedasticity

Source: Author`s estimation

Several criteria that make a regression model reliable can be identified based on the assumptions of multiple regression analysis. First, the model should not contain autocorrelations or serial correlations. This means that errors and residuals are uncorrelated over time. Second, the variables in the model should have equal variances. This means that the variance of the error term should be constant across the various regression values. The errors should also be distributed evenly, preferably in a normal distribution. Also, the model should be linear. This means that the relationship between dependent and independent variables can be expressed using linear parameters or coefficients. Finally, the model's variables should be stable and not subject to abrupt changes.

Numerous diagnostic tests are commonly used to assess these criteria in an econometric analysis. The LM test is used to detect serial correlation, whereas the Breusch-Pagan-Godfrey test examines heteroscedasticity, and the normality test examines the distribution's normality. Researchers can assess the presence or absence of serial correlation, heteroscedasticity, and normalcy by analyzing the results of these tests.

Based on the reported results, if the diagnostic test probability value is greater than the 5% significance level, we can accept the null hypothesis. This means that the model contains no evidence of serial correlation, heteroscedasticity, or non-linearity. Figures 3 and 4 show how the data is normally distributed for the two countries.

Figure 6. Normality Test India

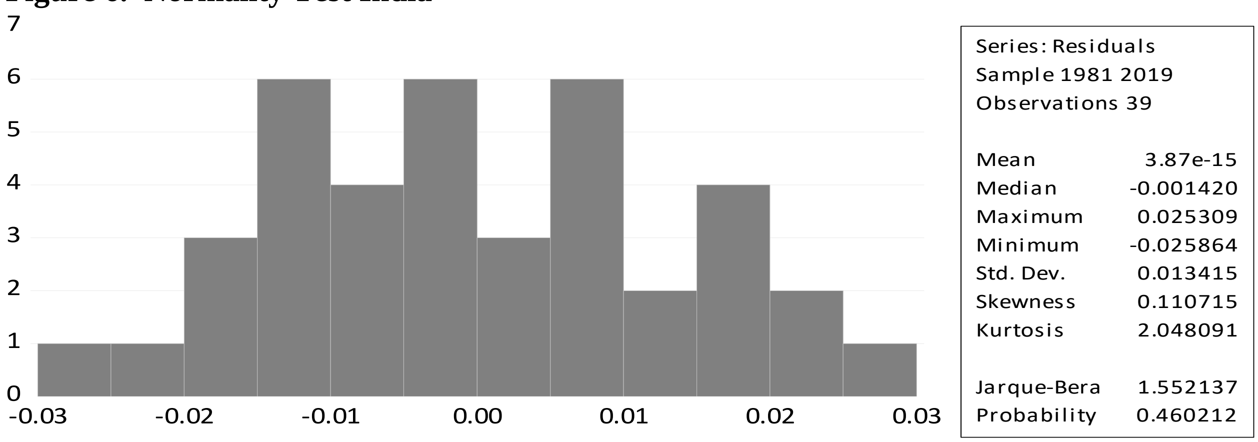


Figure 7. Normality Test China

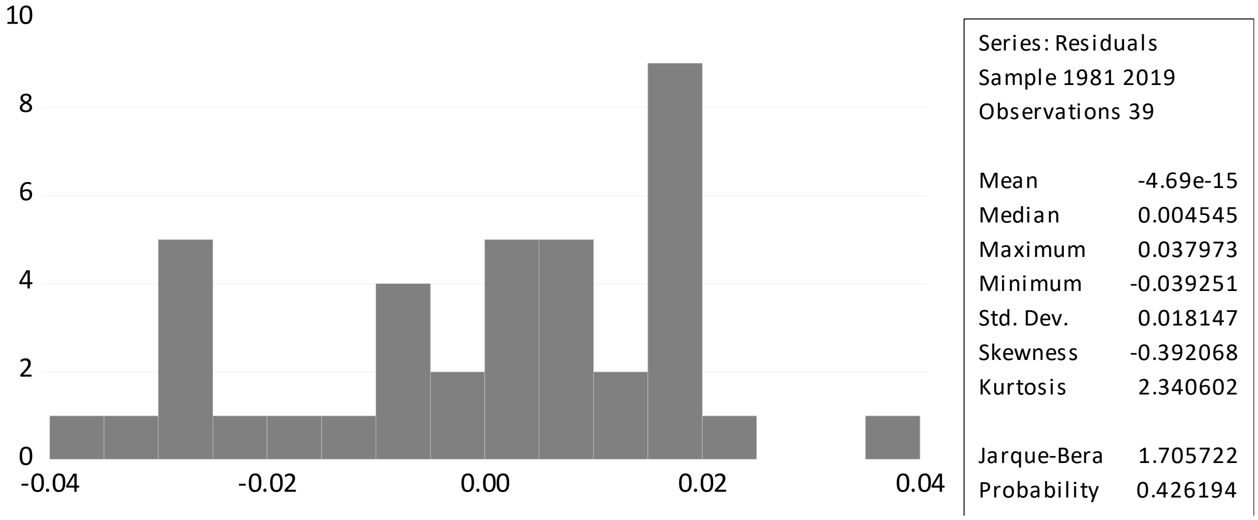

10
8
6
4
2
0
-0.04
-0.02
0.00
0.02
0.04
Series: Residuals
Sample 1981 2019
Observations 39
Mean -4.69e-15
Median 0.004545
Maximum 0.037973
Minimum -0.039251
Std. Dev. 0.018147
Skewness -0.392068
Kurtosis 2.340602
Jarque-Bera 1.705722
Probability 0.426194

Figure 8. Cusum Test India

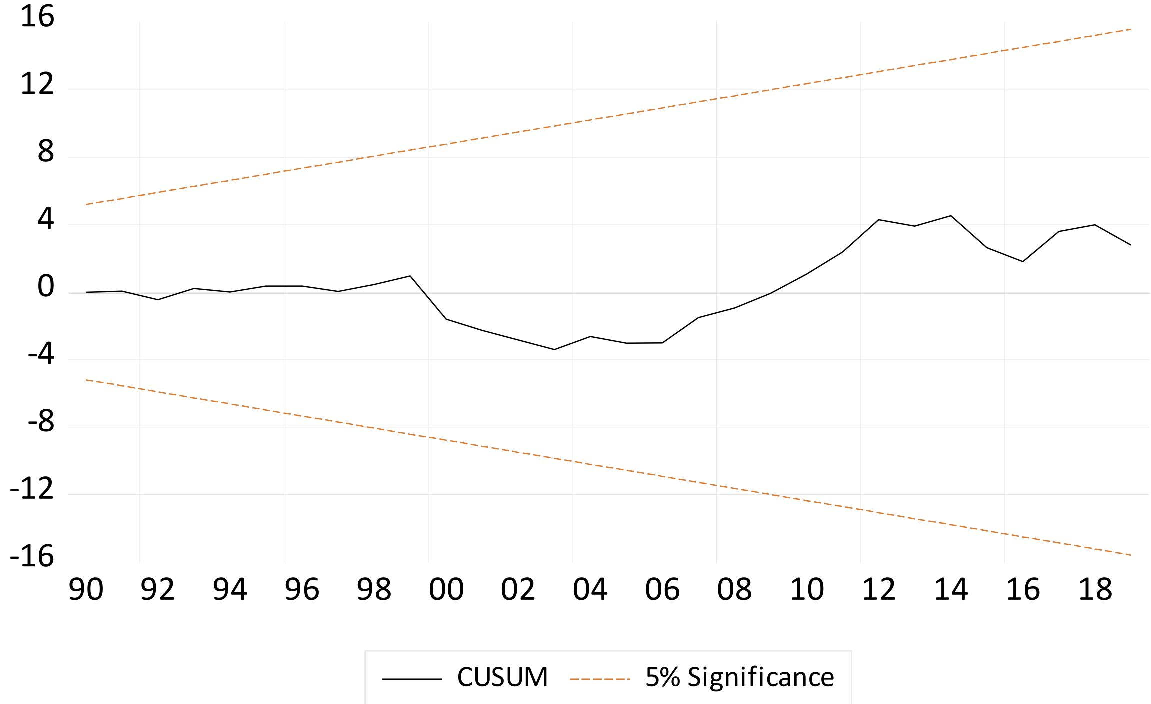
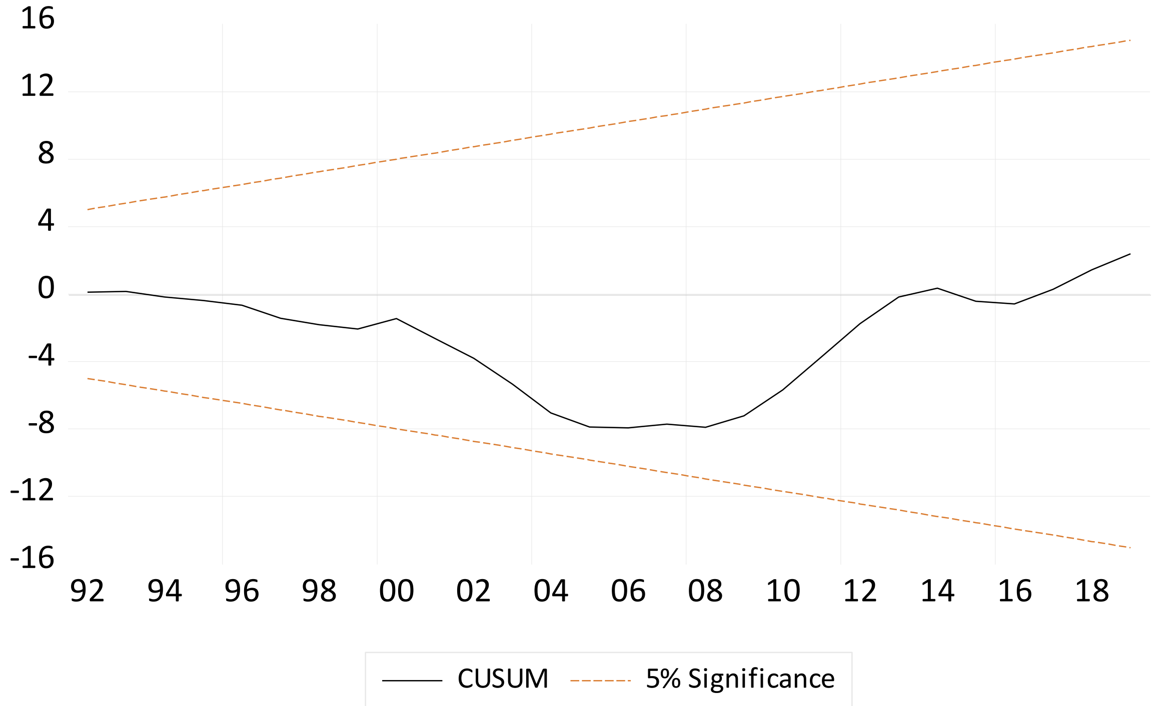


Figure 9. Cusum Test China



Overall, the analysis of the two tests suggested that the variables used in the study are stable over the observed period. The graphical representations of CUSUM diagrams for India and China in Figures 5 and 6, respectively, support this conclusion. In these plots, it is observed that the line representing the CUSUM does not intersect the 5% critical limit. This finding suggests that there is no evidence of structural instability in macroeconomic variables affecting carbon emissions in the economy. As a result, the stability of the estimated coefficients is enhanced. Furthermore, the CUSUM plot remains within the critical limits of 5% significance, demonstrating that structural instability has no impact on the estimated parameters.

8.7 Granger causality results for India and China

The Granger causality test is a statistical test that identifies causal relationships between two time series variables to understand the dynamics and interactions between variables over time. Determines whether past values of one variable can predict future values of another variable. Analyzing the p-values of the tests shows that one Granger variable causes the others. This indicates that there is a predictive relationship between the two variables.

The results in Tables 15 and 16 provide a causality orientation for both countries to examine the sequence of events that led to the observed association. A significant p-value indicates a one-way causal relationship between income inequality and carbon emissions in both countries (Chandia et al., 2018). There is a unidirectional relationship between trade openness and carbon emissions and a bidirectional relationship between trade openness and carbon emissions in India and China. China's growing trade openness and industrialization are the result of carbon emissions. In China, income inequality leads to trade liberalization and industrialization, while in Germany, it leads to fossil fuels. GDP is driven by renewable energy and industrialization in both countries, with China's trade opening and India's industrialization going both ways. In India, there is a causal relationship between fossil fuels and renewable energy, but in China, the relationship is reversed. There is a clear causal relationship between the two countries' GDP and trade openness. However, population growth is impacting India's GDP.

Table 15. Granger Causality India

Variables	Probability
TRA → LCO2	0.0007***
GINI → LCO2	0.0190**
IND → LCO2	8.E-05***
GINI → TRA	0.0105**
GINI → IND	0.0316**
REC → LGDP	0.0290**

POP → LGDP	0.0150**
IND → LGDP	0.0322**
LGDP → IND	0.0111**
LGDP → TRA	0.0002***
FFE → REC	0.0187**
IND → REC	0.0448**
IND → FFE	0.0091***
TRA → POP	0.0227*

Source: Author`s estimation
Note: *, ** and specify the significance of variables at 10%, 5% and 1% respectively**

Table 16. Granger Causality China

Variables	Probability
GINI → LCO2	0.0062
POP → LCO2	0.0338
TRA → LCO2	0.0194
LCO2 → TRA	0.0405
LCO2 → IND	0.0938
FFE → LGDP	0.0271
REC → LGDP	0.0055
IND → LGDP	0.0347
TRA → LGDP	0.0328
LGDP → TRA	0.0367
FFE → TRA	0.0188
REC → TRA	0.0447
REC → FFE	0.0399
GINI → REC	0.0012
TRA → REC	0.0048

Source: Author`s estimation
Note: *, ** and specify the significance of variables at 10%, 5% and 1% respectively**

The causality test results show that there is a two-way causality between energy consumption and CO2 emissions and between CO2 emissions and free trade. This is consistent with Yang et al. (2020). These results highlight the importance of Pakistan implementing energy efficiency and energy conservation policies to reduce carbon emissions, maintain environmental quality, and improve the country's economic performance.

CHAPTER 9 CONCLUSION AND RECOMMENDATION

9.1 Conclusion

This study uses China and India to examine climate change issues and the need for sustainable development. In order to reach a more economical future, it stresses the significance of tackling CO2 emissions, income inequality, trade openness, energy sources, and economic development. By examining the connections between these factors and their effect on carbon emissions and income disparity in both nations, this study hopes to close a knowledge vacuum in the field. The research adds to our knowledge of the obstacles and prospects for attaining sustainable development in China and India by analyzing these issues and recommending potential policy responses. It also emphasizes the need for more research into the intricate interplay of these factors and their possible policy consequences.

The Environmental Kuznet Curve (EKC) suggests an inverted U-shaped relationship between economic development and environmental degradation. Developing nations cause a rise in environmental degradation at first, but this trend reverses as the population becomes richer and more ecologically aware (Munasinghe, 1999). Factors like land, labor, capital, and technology are all considered in the classical economics theory produced by economists like Adam Smith, David Ricardo, and Thomas Malthus. When it comes to production, pricing, and consumer behavior, neoclassical economics theory, which developed in the late 19th century, puts the spotlight squarely on supply and demand. Value is said to be established by how something is perceived by buyers as opposed to how much it really costs to produce.

How civilizations make the shift from subsistence agriculture to industrialized city life is the subject of the modernization theory of urbanization. Economic expansion, technological progress, and shifts in social and cultural norms are all posited to promote urbanization, suggesting that this process is fundamental to modernity. To quantify the degree of economic inequality within a group, statisticians use the Gini coefficient and the Lorenz curve hypothesis. The original range of Corrado Gini's Gini coefficient was from 0 (perfect equality) to 1 (perfect inequality). The Lorenz curve draws parallels between the share of total wealth, or income, and the population as a whole. These theories have been criticized and shown to have shortcomings while providing frameworks for understanding economic growth, environmental sustainability, urbanization, and inequality.

They tend to simplify intricate connections and overlook important factors like history and institutional frameworks. Nonetheless, their impact on economic study and policymaking remains strong.

In contemporary cultures, income disparity has a considerable influence on economic development, social cohesion, and individual well-being (Coburn, 2000). Technological advancements, globalization, economic progress, economic stability, domestic policies, inflation, unemployment, demographic variables, political consequences, and the availability of natural resources are all factors that contribute to income disparity. Income inequality in China has risen as a result of the country's move to a market-oriented economy, growing urbanization and industrialization, the hukou system, and the concentration of wealth and power. The old caste structure, uneven distribution of land and resources, growing urbanization, and gender inequality all contribute to economic disparity in India. Promoting educational fairness, eliminating the employment protection gap between temporary and permanent jobs, enhancing the quality and accessibility of education, and boosting investment in active labor market policy are some remedies to income disparity. These policies attempt to foster social mobility, minimize labor-market gaps, expand educational options, and promote equitable job chances.

The study also looked at economic growth's effects on environmental quality. It starts by emphasizing the rising knowledge of the connection between economic activity and environmental sustainability. Economic development can have three impacts on the environment: it can improve environmental quality by increasing income and funding for public services; it can cause deterioration but eventually lead to improvement with proper long-term planning and resource allocation; or it can accelerate environmental degradation. According to the World Bank, poor nations will produce five times more by 2030, while developed countries will treble their output (Ng-Kamstra et al., 2016). Pollution, on the other hand, will have serious effects if it continues at its present pace, inflicting disease and lasting harm to the earth. Economic growth and environmental protection are not mutually exclusive, and economic development is hindered without proper environmental protection. The availability and conservation of natural resources are essential for economic prosperity. Some resources, such as water and forests, are threatened, while others, such as metals and energy, are not because their market prices reflect their scarcity. To safeguard natural resources, good environmental governance, education, and incentives are required. Development, poverty reduction, and environmental conservation are all mutually beneficial in the long term, but there may be trade-offs in the short run. Poverty causes environmental deterioration, yet unchecked economic growth harms both the environment and the poor.

Environmental policy choices sometimes favor economic effects above ecological repercussions, and environmental principles must be considered while making economic policy decisions. Sustainable economic growth may lead to technological improvements such as renewable energy, which minimize pollution and resource consumption (Fang et al., 2022). Economic success enhances environmental awareness and encourages environmentally friendly purchase patterns. It promotes conservation efforts, research and development of environmentally friendly techniques, green employment creation, and environmental education. Economic expansion, however, has a detrimental influence on environmental quality. Pollution and climate change are exacerbated using fossil fuels, while industrial activities pollute the air, water, and soil. Natural resource depletion and increasing urbanization exacerbate the damage done to ecosystems and biodiversity.

International trade has a large influence on the environment, both positively and negatively. Deforestation, habitat loss, carbon emissions, resource depletion, pollution, and water shortages are all negative consequences of international commerce. These problems are caused by unsustainable logging, land clearance, long-distance transportation, energy-intensive manufacturing processes, overexploitation of natural resources, and insufficient waste management. It encourages the interchange of information, technology, and best practices, which leads to the creation of green technologies and the dissemination of environmental standards (Boiral, 2002). Trade benefits may incentivize governments to protect natural resources, promote ecotourism, and implement sustainable practices. Furthermore, trade agreements enable international cooperation to solve global environmental problems such as climate change and biodiversity loss. The negative environmental impacts of international trade can be mitigated, and a more environmentally responsible and sustainable trade system can be achieved by encouraging sustainable production and consumption, implementing and enforcing environmental norms, promoting eco-labeling and responsible sourcing, and fostering international partnerships.

Countries recognize the importance of shifting to renewable energy to combat climate change and CO_2 emissions (Bokpin, 2017). China makes significant investments in wind, solar, and hydroelectric power. In India, solar and wind power installations have also increased. These efforts are required to reduce the carbon intensity of their economies and achieve sustainable development goals. Income inequality has risen in recent decades in India. In the early 2000s, it rose in India while falling in China (Mahalik et al., 2021). In order to achieve inclusive growth, income inequality must be addressed, as it can undermine social cohesion. CO2 emissions and trade openness were also investigated. International trade has the potential to increase or decrease CO2 emissions. Because of transportation and logistics, trade may increase emissions. It enables technology transfer and cleaner manufacturing methods. The study also emphasizes the importance of distributing trade benefits to reduce income inequality. Economic development requires growth, but it also increases energy consumption and emissions. Both countries struggle to find a balance between economic growth and environmental sustainability. Sustainable policies and practices are critical to decoupling economic growth from carbon emissions.

The research goal is to explore the links between CO2 emissions, trade openness, income inequality, renewable and non-renewable energy, and economic growth. It also explores the factors influencing carbon emissions and income inequality, with a focus on China and India. Annual data from a World Bank global development indicator from 1980 to 2019 was used. It employs quantitative techniques such as Granger causality tests, unit root tests, ARDL bound tests, short-run ARDL and ECM models, estimated long-run coefficients, and residual diagnostics tests within a framework for comparative analysis. A residual diagnostic test was used to assess the quality and fit of the regression model. The autocorrelation, heteroscedasticity, normality, and stability of the variables were all evaluated. The results demonstrated that the models met the necessary criteria, and the data for both countries was normally distributed.

Three of the variables, such as renewable energy, fossil fuels, and population growth, were found to be integrated at order zero, indicating that there are no unit root problems. Carbon emissions, GDP, income inequality, trade, and industrialization remained stable after the initial divergence. In India, the extended Dickey-Fuller (ADF) and Philippe-Perron (PP) unit root tests gave consistent results. China's results, on the other hand, were more mixed and inconsistent. The ARDL-bound test found long-term relationships between variables in both countries. F-statistics for India and China showed significant long-term relationships between variables. Short-term ARDL and ECM models provided insight into short-term dynamics and the rate of adjustment towards long-term equilibrium. The coefficient estimations of the short-run model revealed positive or negative relationships between variables, with significant results for most variables in India and some in China. GDP, fossil fuels, and trade opening have all had a positive impact on India's carbon emissions, which agrees with Y. Chen et al. (2019), but renewable energy, income inequality, and population growth had a negative impact. Similar relationships were discovered in China, except for trade openness and industrialization, neither of which had a big impact on CO2 emissions. Long-run estimates predicted similar results. GDP, fossil fuels, and trade openness all had a positive impact on carbon emissions in both countries, while renewable energy change, income inequality, and population growth all had a negative impact (Ohlan, 2015). Changes in the independent variables had a long-term impact on carbon emissions, as represented by the coefficients. The Granger causality test was used to determine causality between variables. According to the findings, both countries' CO2 emissions were caused by income inequality (Chandia et al., 2018). The relationship between trade openness and carbon emissions was two-way in China but one-way in India. Furthermore, in both countries, there were causal relationships between GDP and other variables.

The results suggest that renewable energy, income equality, and population growth could all play important roles in reducing carbon emissions in both countries. It identifies key factors affecting carbon emissions and income inequality in both countries and proposes strategies for long-term development. Policymakers should prioritize long-term development strategies that strike a balance between economic growth, environmental protection, and social justice. Promoting investments in renewable energy, technological innovation, and energy efficiency measures can aid decrease CO2 emissions while advancing economic development. Effective and equitable strategies that prioritize renewable energy adoption, reduce income disparities, and promote sustainable development for present and future generations are critical as China and India pursue economic growth while addressing environmental issues.

9.2 Recommendations

This study explores how China and India are addressing the challenges of climate change and the need for sustainable development. The research's main purpose is to provide useful information to lawmakers and academics in China and India who are engaged in efforts to better the country's environment and economy. The research has led to several suggestions, including the following:

Increasing the use of renewable energy sources such as solar and wind is important to reduce carbon emissions and achieve sustainable development (Omer, 2008). Both China and India should put various measures in place to help facilitate this change. Governments can offer subsidies and incentives to encourage the development of renewable energy projects and attract investment. Investment in R&D may also lead to breakthroughs in renewable energy production. Private investment in the renewable energy sector can be encouraged by creating an appropriate legal and regulatory framework.

Increasing energy efficiency is essential if we are to successfully reduce global CO2 emissions (Abdul Quader et al., 2016). Industry, transportation, buildings, and appliances in China and India may all benefit from the use of energy-saving techniques. To this end, it is important to deploy energy-efficient technology, set energy efficiency standards, encourage energy-saving habits, and increase consumer and business understanding of the need for energy efficiency. Energy-efficient practices not only lessen the environmental impact but also save costs and increase productivity.

Resolve the problem of income disparity, which is a serious social and economic problem (Grigoryev & Pavlyushina, 2020). In order to strengthen social cohesiveness and stability, governments in China and India should implement policies that narrow income disparities. Social welfare programs and progressive taxation systems both contribute to a more just distribution of income. Investing in people's education and the acquisition of new skills may improve their employment and promotion opportunities. Further, promoting economic development that is broadly shared may help bring down income inequality. While commerce may help the economy expand, it also has the potential to increase pollution if it isn't controlled properly. The trade policies of China and India should give preference to low-carbon and environmentally friendly sectors. Green supply chain development, the promotion of sustainable consumption practices, and the integration of environmental considerations into trade legislation all contribute to this goal. The negative environmental impact of commercial activities can be mitigated by promoting environmentally sound business practices and supporting sustainable manufacturing techniques.

To improve reporting and tracking mechanisms by reducing carbon dioxide emissions and tackling economic inequalities, robust monitoring and reporting systems are needed (World Bank, 2013). To evaluate the success of policies and programs, China and India should fund improvements to data collection, analysis, and reporting. The implementation of the SDGs will be more transparent and accountable, and more informed decisions can be made based on this data.

Increased education of the public and encouraging their participation is essential for bringing about change in the areas of sustainable development, climate change, and economic inequality. (Leicht et al., 2018). Governments should engage people via information campaigns, media outreach, and open forums. By raising awareness of the challenges and possibilities of sustainable development, we can empower individuals to make well-informed choices and contribute to collective efforts. A sense of ownership and commitment to sustainable development objectives may be fostered through public engagement and involvement in decision-making processes.

Motivate government, business, and civic society to work together. Society private, and civil society must work together to achieve sustainable development. In order to generate novel solutions, pool resources, and advance mutual objectives, China and India should build channels of interaction between these parties. Sustainable energy initiatives and reducing economic disparity may both benefit from public-private collaborations. Involvement from civil society groups in the policymaking process has the potential to provide more inclusive, responsive, and effective results.

REFERENCES

Abdul Quader, M., Ahmed, S., Dawal, S. Z., & Nukman, Y. (2016). Present needs, recent progress and future trends of energy-efficient Ultra-Low Carbon Dioxide (CO) Steelmaking (ULCOS) program. *Renewable and Sustainable Energy Reviews*, *55*, 537–549. https://doi.org/10.1016/j.rser.2015.10.101

Alam, M. J., Begum, I. A., Buysse, J., Rahman, S., & Van Huylenbroeck, G. (2011). Dynamic modeling of causal relationship between energy consumption, CO2 emissions and economic growth in India. *Renewable and Sustainable Energy Reviews*, *15*(6), 3243–3251. https://doi.org/10.1016/j.rser.2011.04.029

Alam, Md. M., Murad, Md. W., Noman, A. H. Md., & Ozturk, I. (2016). Relationships among carbon emissions, economic growth, energy consumption and population growth: Testing Environmental Kuznets Curve hypothesis for Brazil, China, India and Indonesia. *Ecological Indicators*, *70*, 466–479. https://doi.org/10.1016/j.ecolind.2016.06.043

Altinay, G. (2007). Short-run and long-run elasticities of import demand for crude oil in Turkey. *Energy Policy*, *35*(11), 5829–5835. https://doi.org/10.1016/j.enpol.2007.07.015

Anthony, I. O., Emmanuel, E. O., Etinosa, O. I., & Augustina, N. O. (2007). Wastewater treatment plants as a source of microbial pathogens in receiving watersheds. *African Journal of Biotechnology*, *6*(25), 2932–2944. https://doi.org/10.5897/AJB2007.000-2462

Aye, G. C. & UNU-WIDER. (2020). *Wealth inequality and CO2 emissions in emerging economies: The case of BRICS* (161st ed., Vol. 2020). UNU-WIDER. https://doi.org/10.35188/UNU-WIDER/2020/918-1

Azomahou, T., Laisney, F., & Nguyen Van, P. (2006). Economic development and CO2 emissions: A nonparametric panel approach. *Journal of Public Economics*, *90*(6–7), 1347–1363. https://doi.org/10.1016/j.jpubeco.2005.09.005

Baloch, M. A., Danish, Khan, S. U.-D., Ulucak, Z. Ş., & Ahmad, A. (2020). Analyzing the relationship between poverty, income inequality, and CO2 emission in Sub-Saharan African countries. *Science of The Total Environment*, *740*, 139867. https://doi.org/10.1016/j.scitotenv.2020.139867

Bassanini, A., & Duval, R. (2006). Employment Patterns in OECD Countries: Reassessing the Role of Policies and Institutions. OECD Economics Department Working Papers No. 486. *OECD Publishing (NJ1).*

Bengtsson, J., Nilsson, S. G., Franc, A., & Menozzi, P. (2000). Biodiversity, disturbances, ecosystem function and management of European forests. *Forest Ecology and Management*, *132*(1), 39–50. https://doi.org/10.1016/S0378-1127(00)00378-9

Berg, A., Ostry, J. D., Tsangarides, C. G., & Yakhshilikov, Y. (2018). Redistribution, inequality, and growth: New evidence. *Journal of Economic Growth*, *23*(3), 259–305. https://doi.org/10.1007/s10887-017-9150-2

Bhattacharya, H. (2020). Environmental and socio-economic sustainability in India: Evidence from CO_2 emission and economic inequality relationship. *Journal of Environmental Economics and Policy*, *9*(1), 57–76. https://doi.org/10.1080/21606544.2019.1604267

Boiral, O. (2002). Tacit Knowledge and Environmental Management. *Long Range Planning*, *35*(3), 291–317. https://doi.org/10.1016/S0024-6301(02)00047-X

Bokpin, G. A. (2017). Foreign direct investment and environmental sustainability in Africa: The role of institutions and governance. *Research in International Business and Finance*, *39*, 239–247. https://doi.org/10.1016/j.ribaf.2016.07.038

Caminada, K., & Goudswaard, K. (2001). International trends in income inequality and social policy. *International Tax and Public Finance*, *8*, 395-415.

Carraro, C., & Siniscalco, D. (1992). The international dimension of environmental policy. *European Economic Review*, *36*(2–3), 379–387. https://doi.org/10.1016/0014-2921(92)90094-D

Causa, O., & Jean, S. (2007). Integration of immigrants in OECD countries: do policies matter?

Champernowne, D., & Cowell , F. (1998). *Economic Inequality and Income Distribution.* Cambridge, UK:: Cambridge University Press.

Chandia, K. E., Gul, I., Aziz, S., Sarwar, B., & Zulfiqar, S. (2018). An analysis of the association among carbon dioxide emissions, energy consumption and economic performance: An econometric model. *Carbon Management*, *9*(3), 227–241. https://doi.org/10.1080/17583004.2018.1457930

Chen, J., Xian, Q., Zhou, J., & Li, D. (2020). Impact of income inequality on CO2 emissions in G20 countries. *Journal of Environmental Management*, *271*, 110987. https://doi.org/10.1016/j.jenvman.2020.110987

Chen, Y., Wang, Z., & Zhong, Z. (2019). CO2 emissions, economic growth, renewable and non-renewable energy production and foreign trade in China. *Renewable Energy*, *131*, 208–216. https://doi.org/10.1016/j.renene.2018.07.047

Chesbrough, H., & Crowther, A. K. (2006). Beyond high tech: Early adopters of open innovation in other industries. *R and D Management*, *36*(3), 229–236. https://doi.org/10.1111/j.1467-9310.2006.00428.x

Chetty, R., Friedman, J. N., Hilger, N., Saez, E., Schanzenbach, D. W., & Yagan, D. (2011). How Does Your Kindergarten Classroom Affect Your Earnings? Evidence from Project Star. *The Quarterly Journal of Economics*, *126*(4), 1593–1660. https://doi.org/10.1093/qje/qjr041

Coburn, D. (2000). Income inequality, social cohesion and the health status of populations: The role of neo-liberalism. *Social Science & Medicine*, *51*(1), 135–146. https://doi.org/10.1016/S0277-9536(99)00445-1

Cornia, G. A., & Kiiski, S. (2001). Trends in income distribution in the post-World War II period: Evidence and interpretation.

Costello, A., Abbas, M., Allen, A., Ball, S., Bell, S., Bellamy, R., Friel, S., Groce, N., Johnson, A., Kett, M., Lee, M., Levy, C., Maslin, M., McCoy, D., McGuire, B., Montgomery, H., Napier, D., Pagel, C., Patel, J., … Patterson, C. (2009). Managing the health effects of climate change. *The Lancet*, *373*(9676), 1693–1733. https://doi.org/10.1016/S0140-6736(09)60935-1

Dasgupta, P. (2007). Commentary: The Stern Review's Economics of Climate Change. *National Institute Economic Review*, *199*, 4–7. https://doi.org/10.1177/0027950107077111

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the Estimators for Autoregressive Time Series with a Unit Root. *Journal of the American Statistical Association*, *74*(366a), 427–431. https://doi.org/10.1080/01621459.1979.10482531

Dresner, M., Handelman, C., Braun, S., & Rollwagen-Bollens, G. (2015). Environmental identity, pro-environmental behaviors, and civic engagement of volunteer stewards in Portland area parks. *Environmental Education Research*, *21*(7), 991–1010. https://doi.org/10.1080/13504622.2014.964188

Dunn, S. (2002). Hydrogen futures: Toward a sustainable energy system. *International Journal of Hydrogen Energy*, *27*(3), 235–264. https://doi.org/10.1016/S0360-3199(01)00131-8

Durham, S. R., Walker, S. M., Varga, E.-M., Jacobson, M. R., O'Brien, F., Noble, W., Till, S. J., Hamid, Q. A., & Nouri-Aria, K. T. (1999). Long-Term Clinical Efficacy of Grass-Pollen Immunotherapy. *New England Journal of Medicine*, *341*(7), 468–475. https://doi.org/10.1056/NEJM199908123410702

Duro, J. A., & Padilla, E. (2006). International inequalities in per capita CO2 emissions: A decomposition methodology by Kaya factors. *Energy Economics*, *28*(2), 170–187. https://doi.org/10.1016/j.eneco.2005.12.004

Edenhofer, O., Hirth, L., Knopf, B., Pahle, M., Schlömer, S., Schmid, E., & Ueckerdt, F. (2013). On the economics of renewable energy sources. *Energy Economics*, *40*, S12–S23. https://doi.org/10.1016/j.eneco.2013.09.015

Estrada, A., Garber, P. A., Mittermeier, R. A., Wich, S., Gouveia, S., Dobrovolski, R., Nekaris, K. A. I., Nijman, V., Rylands, A. B., Maisels, F., Williamson, E. A., Bicca-Marques, J., Fuentes, A., Jerusalinsky, L., Johnson, S., Rodrigues De Melo, F., Oliveira, L., Schwitzer, C., Roos, C., … Setiawan, A. (2018). Primates in peril: The significance of Brazil, Madagascar, Indonesia and the Democratic Republic of the Congo for global primate conservation. *PeerJ*, *6*, e4869. https://doi.org/10.7717/peerj.4869

Falendra Kumar Sudan. (2022). Trade Openness and Economic Growth in China and India in Comparative Perspective: An Exploratory Study. *Regional Economic Development Research*, 1–13. https://doi.org/10.37256/redr.3120221091

Fan, C. C. (2006). China's Eleventh Five-Year Plan (2006-2010): From "Getting Rich First" to "Common Prosperity." *Eurasian Geography and Economics*, *47*(6), 708–723. https://doi.org/10.2747/1538-7216.47.6.708

Fan, W., Li, L., Wang, F., & Li, D. (2020). Driving factors of CO2 emission inequality in China: The role of government expenditure. *China Economic Review*, *64*, 101545. https://doi.org/10.1016/j.chieco.2020.101545

Fang, W., Liu, Z., & Surya Putra, A. R. (2022). Role of research and development in green economic growth through renewable energy development: Empirical evidence from South Asia. *Renewable Energy*, *194*, 1142–1152. https://doi.org/10.1016/j.renene.2022.04.125

Farhani, S., Chaibi , A., & Rault, C. (2014). *A Study of CO2 Emissions Output, Energy Consumption, and Trade.* Paris: IPAG Business School.

Fei, X. (1992). *Foundation of the Chinese Society*. Shanghai: California University Press.

Fournier, J. M., & Koske, I. (2013). The determinants of earnings inequality: evidence from quantile regressions. *OECD Journal: Economic Studies*, *2012*(1), 7-36.

Galli, A., Halle, M., & Grunewald, N. (2015). Physical limits to resource access and utilisation and their economic implications in Mediterranean economies. *Environmental Science & Policy*, *51*, 125–136. https://doi.org/10.1016/j.envsci.2015.04.002

Ghazouani, T., & Beldi, L. (2021). *The Impact of Income Inequality on Carbon Emissions in Asian Countries: Non-Parametric Panel Data Analysis* [Preprint]. In Review. https://doi.org/10.21203/rs.3.rs-451635/v1

Gradín, C., Wu, B., & UNU-WIDER. (2019). *Income and consumption inequality in China: A comparative approach with India* (54th ed., Vol. 2019). UNU-WIDER. https://doi.org/10.35188/UNU-WIDER/2019/688-3

Gregorio, J. D., & Lee, J.-W. (2002). Education and Income Inequality: New Evidence From Cross-Country Data. *Review of Income and Wealth*, *48*(3), 395–416. https://doi.org/10.1111/1475-4991.00060

Grigoryev, L., & Pavlyushina, V. (2020). Global Recession and Income Inequality: Factors of Disruption for Elites in the Twenty-First Century. In L. Grigoryev & A. Pabst (Eds.), *Global Governance in Transformation* (pp. 275–297). Springer International Publishing. https://doi.org/10.1007/978-3-030-23092-0_17

Grossman, G., & Krueger, A. (1991). *Environmental Impacts of a North American Free Trade Agreement* (No. w3914; p. w3914). National Bureau of Economic Research. https://doi.org/10.3386/w3914

Guo, L. (2013). Cross-country income disparity and its effect on carbon emissions. *Chinese Journal of Population Resources and Environment*, *11*(1), 33–50. https://doi.org/10.1080/10042857.2013.777208

Guo, Y., You, W., & Lee, C.-C. (2022). CO2 emissions, income inequality, and country risk: Some international evidence. *Environmental Science and Pollution Research*, *29*(9), 12756–12776. https://doi.org/10.1007/s11356-020-09501-w

Hailemariam, A., Dzhumashev, R., & Shahbaz, M. (2020). Carbon emissions, income inequality and economic development. *Empirical Economics*, *59*(3), 1139–1159. https://doi.org/10.1007/s00181-019-01664-x

Hart, S. L., & Milstein, M. B. (2003). Creating sustainable value. *Academy of Management Perspectives*, *17*(2), 56–67. https://doi.org/10.5465/ame.2003.10025194

Henton, D., Melville, J., & Walesh, K. (1997). The age of the civic entrepreneur: restoring civil society and building economic community. *National Civic Review*, *86*(2), 149+. https://link.gale.com/apps/doc/A19965534/AONE?u=anon~16f9bfa9&sid=googleScholar&xid=29380ea0

Huang, Z., & Duan, H. (2020). Estimating the threshold interactions between income inequality and carbon emissions. *Journal of Environmental Management*, *263*, 110393. https://doi.org/10.1016/j.jenvman.2020.110393

Huo, C., & Chen, L. (2022). The Impact of the Income Gap on Carbon Emissions: Evidence from China. *Energies*, *15*(10), 3771. https://doi.org/10.3390/en15103771

Jayanthakumaran, K., Verma, R., & Liu, Y. (2012). CO2 emissions, energy consumption, trade and income: A comparative analysis of China and India. *Energy Policy, 42*, 450–460. https://doi.org/10.1016/j.enpol.2011.12.010

Jiao, Z., Xing, Z., Zhang, G., Ma, X., & Wang, H. (2022). Comparing Decoupling and Driving Forces of CO2 Emissions in China and India. *Frontiers in Environmental Science, 10*, 847062. https://doi.org/10.3389/fenvs.2022.847062

John, A., & Pecchenino, R. (1994). An Overlapping Generations Model of Growth and the Environment. *The Economic Journal*, vol.-108, 1393 - 1410.

Jorgenson, A. K. (2006). Unequal Ecological Exchange and Environmental Degradation: A Theoretical Proposition and Cross-National Study of Deforestation, 1990-2000*. *Rural Sociology*, *71*(4), 685–712. https://doi.org/10.1526/003601106781262016

Jorgenson, A. K., Schor, J. B., Knight, K. W., & Huang, X. (2016). Domestic Inequality and Carbon Emissions in Comparative Perspective. *Sociological Forum, 31*, 770–786. https://doi.org/10.1111/socf.12272

Jorgenson, A., Schor, J., & Huang, X. (2017). Income Inequality and Carbon Emissions in the United States: A State-level Analysis, 1997–2012. *Ecological Economics, 134*, 40–48. https://doi.org/10.1016/j.ecolecon.2016.12.016

Kabisch, N. (2015). Ecosystem service implementation and governance challenges in urban green space planning—The case of Berlin, Germany. *Land Use Policy*, *42*, 557–567. https://doi.org/10.1016/j.landusepol.2014.09.005

Keenan, R. J. (2015). Climate change impacts and adaptation in forest management: A review. *Annals of Forest Science*, *72*(2), 145–167. https://doi.org/10.1007/s13595-014-0446-5

Khan, S., & Yahong, W. (2021). *Income Inequality, Ecological Footprint, and Carbon Dioxide Emissions in Asian Developing Economies: What Effects What and How?* [Preprint]. In Review. https://doi.org/10.21203/rs.3.rs-687484/v1

Knight, K. W., Schor, J. B., & Jorgenson, A. K. (2017). Wealth Inequality and Carbon Emissions in High-income Countries. *Social Currents*, *4*(5), 403–412. https://doi.org/10.1177/2329496517704872

Kolodko, G. W. (2002). *Globalization and Catching-up in Transitional Economies.* NY and UK: Rochester.

Koske, I., Fournier, J. M., & Wanner, I. (2012). Less income inequality and more growth–Are they compatible? Part 2. The distribution of labour income.

Kotler, P. (2011). Reinventing Marketing to Manage the Environmental Imperative. *Journal of Marketing*, *75*(4), 132–135. https://doi.org/10.1509/jmkg.75.4.132

Krishnan, R., Sanjay, J., Gnanaseelan, C., Mujumdar, M., Kulkarni, A., & Chakraborty, S. (Eds.). (2020). *Assessment of Climate Change over the Indian Region: A Report of the Ministry of Earth Sciences (MoES), Government of India*. Springer Singapore. https://doi.org/10.1007/978-981-15-4327-2

Kuznet, S. (1955). Economic Growth and Income Inequality. *The American Economic Review,* 45(1), 1-28.

Lardner, D. (1850). *Railway Economy.* London: Harper & Brothers.

Laroche, M., Bergeron, J., & Barbaro-Forleo, G. (2001). Targeting consumers who are willing to pay more for environmentally friendly products. *Journal of Consumer Marketing*, *18*(6), 503–520. https://doi.org/10.1108/EUM0000000006155

Leicht, A., Heiss, J., & Byun, W. J. (2018). *Issues and trends in education for sustainable development* (Vol. 5). UNESCO publishing.

Lenzen, M., Li, M., Malik, A., Pomponi, F., Sun, Y.-Y., Wiedmann, T., Faturay, F., Fry, J., Gallego, B., Geschke, A., Gómez-Paredes, J., Kanemoto, K., Kenway, S., Nansai, K., Prokopenko, M., Wakiyama, T., Wang, Y., & Yousefzadeh, M. (2020). Global socio-economic losses and environmental gains from the Coronavirus pandemic. *PLOS ONE, 15*(7), e0235654. https://doi.org/10.1371/journal.pone.0235654

Leonidou, L. C., Leonidou, C. N., & Kvasova, O. (2010). Antecedents and outcomes of consumer environmentally friendly attitudes and behaviour. *Journal of Marketing Management*, *26*(13–14), 1319–1344. https://doi.org/10.1080/0267257X.2010.523710

Levinson, A. (1999). *An Industry-Adjusted Index of State Environmental Compliance Costs* (No. w7297; p. w7297). National Bureau of Economic Research. https://doi.org/10.3386/w7297

Li, J., & Li, Z. (2011). A Causality Analysis of Coal Consumption and Economic Growth for China and India. *Natural Resources*, *02*(01), 54–60. https://doi.org/10.4236/nr.2011.21007

Li, K.-W. (2017). China's Economic Reform Path. In *Redefining Capitalism in Global Economic Development* (pp. 331–358). Elsevier. https://doi.org/10.1016/B978-0-12-804181-9.00015-X

Liang, W., & Yang, M. (2019). Urbanization, economic growth and environmental pollution: Evidence from China. *Sustainable Computing: Informatics and Systems*, *21*, 1–9. https://doi.org/10.1016/j.suscom.2018.11.007

Liobikienė, G. (2020). The revised approaches to income inequality impact on production-based and consumption-based carbon dioxide emissions: Literature review. *Environmental Science and Pollution Research*, *27*(9), 8980–8990. https://doi.org/10.1007/s11356-020-08005-x

Liu, Q., Wang, S., Zhang, W., Li, J., & Kong, Y. (2019). Examining the effects of income inequality on CO2 emissions: Evidence from non-spatial and spatial perspectives. *Applied Energy*, *236*, 163–171. https://doi.org/10.1016/j.apenergy.2018.11.082

LóPez, R. (1994). The environment as a factor of production: the effects of economic growth and trade liberalization,. *Journal of Environmental Economics and Management*, vol.-27, 163 – 184. .

Mahalik, M. K., Mallick, H., & Padhan, H. (2021). Do educational levels influence the environmental quality? The role of renewable and non-renewable energy demand in selected BRICS countries with a new policy perspective. *Renewable Energy*, *164*, 419–432. https://doi.org/10.1016/j.renene.2020.09.090

Malthus, T. (1798). Essay on the Principle of Population. *1st edn. London: Macmillan,* .

Manisalidis, I., Stavropoulou, E., Stavropoulos, A., & Bezirtzoglou, E. (2020). Environmental and Health Impacts of Air Pollution: A Review. *Frontiers in Public Health*, *8*, 14. https://doi.org/10.3389/fpubh.2020.00014

Marginson, S. (2018). Public/private in higher education: A synthesis of economic and political approaches. *Studies in Higher Education*, *43*(2), 322–337. https://doi.org/10.1080/03075079.2016.1168797

Marshall, A. 1. (1920). *Principles of Economics,*. London: Macmillan.

McAfee, K. (1999). Selling Nature to save It? Biodiversity and Green Developmentalism. *Environment and Planning D: Society and Space*, *17*(2), 133–154. https://doi.org/10.1068/d170133

Moshood, T. D., Nawanir, G., Mahmud, F., Mohamad, F., Ahmad, M. H., & AbdulGhani, A. (2022). Sustainability of biodegradable plastics: New problem or solution to solve the global plastic pollution? *Current Research in Green and Sustainable Chemistry*, *5*, 100273. https://doi.org/10.1016/j.crgsc.2022.100273

Munasinghe, M. (1999). Is environmental degradation an inevitable consequence of economic growth: Tunneling through the environmental Kuznets curve. *Ecological Economics*, *29*(1), 89–109. https://doi.org/10.1016/S0921-8009(98)00062-7

Munthali, S. M. (2007). Transfrontier conservation areas: Integrating biodiversity and poverty alleviation in Southern Africa. *Natural Resources Forum*, *31*(1), 51–60. https://doi.org/10.1111/j.1477-8947.2007.00130.x

Mushinski, D. W., & Pickering, K. (2000). Inequality in Income Distributions: Does Culture Matter? An Analysis of Western Native American Tribes. *Journal of Economic Issues*, *34*(2), 403–412. https://doi.org/10.1080/00213624.2000.11506279

Nasir, M. A., Canh, N. P., & Lan Le, T. N. (2021). Environmental degradation & role of financialisation, economic development, industrialisation and trade liberalisation. *Journal of Environmental Management*, *277*, 111471. https://doi.org/10.1016/j.jenvman.2020.111471

Nehru, J. (1946). *Inter-Asian Relations.* India: Oxford Press.

Ng-Kamstra, J. S., Greenberg, S. L. M., Abdullah, F., Amado, V., Anderson, G. A., Cossa, M., Costas-Chavarri, A., Davies, J., Debas, H. T., Dyer, G. S. M., Erdene, S., Farmer, P. E., Gaumnitz, A., Hagander, L., Haider, A., Leather, A. J. M., Lin, Y., Marten, R., Marvin, J.

T., … Shrime, M. G. (2016). Global Surgery 2030: A roadmap for high income country actors. *BMJ Global Health*, *1*(1), e000011. https://doi.org/10.1136/bmjgh-2015-000011

O'Connor, M. I., Mori, A. S., Gonzalez, A., Dee, L. E., Loreau, M., Avolio, M., Byrnes, J. E. K., Cheung, W., Cowles, J., Clark, A. T., Hautier, Y., Hector, A., Komatsu, K., Newbold, T., Outhwaite, C. L., Reich, P. B., Seabloom, E., Williams, L., Wright, A., & Isbell, F. (2021). Grand challenges in biodiversity–ecosystem functioning research in the era of science–policy platforms require explicit consideration of feedbacks. *Proceedings of the Royal Society B: Biological Sciences*, *288*(1960), 20210783. https://doi.org/10.1098/rspb.2021.0783

Ohlan, R. (2015). The impact of population density, energy consumption, economic growth and trade openness on CO2 emissions in India. *Natural Hazards*, *79*(2), 1409–1428. https://doi.org/10.1007/s11069-015-1898-0

Omer, A. M. (2008). Energy, environment and sustainable development. *Renewable and Sustainable Energy Reviews*, *12*(9), 2265–2300. https://doi.org/10.1016/j.rser.2007.05.001

Padilla, E., & Duro, J. A. (2013). Explanatory factors of CO2 per capita emission inequality in the European Union. *Energy Policy*, *62*, 1320–1328. https://doi.org/10.1016/j.enpol.2013.07.018

Padilla, E., & Serrano, A. (2006). Inequality in CO2 emissions across countries and its relationship with income inequality: A distributive approach. *Energy Policy*, *34*(14), 1762–1772. https://doi.org/10.1016/j.enpol.2004.12.014

Pearce, D., Putz, F. E., & Vanclay, J. K. (2003). Sustainable forestry in the tropics: Panacea or folly? *Forest Ecology and Management*, *172*(2–3), 229–247. https://doi.org/10.1016/S0378-1127(01)00798-8

Pesaran, H. (1997). The Role of Economic Theory in Modelling the Long Run. *The Economic Journal*, 178-191.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, *16*(3), 289–326. https://doi.org/10.1002/jae.616

Pradhan, P., Costa, L., Rybski, D., Lucht, W., & Kropp, J. P. (2017). A Systematic Study of Sustainable Development Goal (SDG) Interactions: A SYSTEMATIC STUDY OF SDG

INTERACTIONS. *Earth's Future*, *5*(11), 1169–1179. https://doi.org/10.1002/2017EF000632

Rai, S. K., Bembey, A. M., & Sarfare, D. (2019). Empirical verification of causality between CO<SUB align="right">2 emissions, energy consumption, foreign direct investment, gross domestic product, and openness of the economy: Evidence from India. *International Journal of Sustainable Economy*, *11*(3), 237. https://doi.org/10.1504/IJSE.2019.100679

Ramsey, F. (1928). Mathematical Theory of Saving". *Economic Journal*, *Vol.38.* , pp.543-559.

Ravallion, M. (2000). Carbon emissions and income inequality. *Oxford Economic Papers*, *52*(4), 651–669. https://doi.org/10.1093/oep/52.4.651

Reisch, L., Eberle, U., & Lorek, S. (2013). Sustainable food consumption: An overview of contemporary issues and policies. *Sustainability: Science, Practice and Policy*, *9*(2), 7–25. https://doi.org/10.1080/15487733.2013.11908111

Ricardo, D. (1817). On The Principles of Political Economy and Taxation. *John Murray, 3rd Edt. Michigan Univ*.

Rubery, J., Keizer, A., & Grimshaw, D. (2016). Flexibility bites back: The multiple and hidden costs of flexible employment policies: Provocation paper: costs of flexible policies. *Human Resource Management Journal*, *26*(3), 235–251. https://doi.org/10.1111/1748-8583.12092

Saidi, K., & Mbarek, M. B. (2017). The impact of income, trade, urbanization, and financial development on CO2 emissions in 19 emerging economies. *Environmental Science and Pollution Research*, *24*(14), 12748–12757. https://doi.org/10.1007/s11356-016-6303-3

Schumpeter, J. (1939). *A Theoretical, Historical and Statistical Analysis of the Capitalist Process.* New York: McGraw-Hill.

Shahani, R., & Bansal, A. (2021). An Econometric Investigation of Dynamic Linkages Between CO_2 Emissions, Energy Consumption, and Economic Growth: A Case of India and China. *Jindal Journal of Business Research*, *10*(1), 107–127. https://doi.org/10.1177/22786821211002252

Shahani, R., & Raghuvansi, K. (2020). Carbon Dioxide Emissions and Economic Growth: A Bivariate Co-integration Analysis for Two Emerging Markets of India and China. *Vision:*

The Journal of Business Perspective, *24*(1), 9–22. https://doi.org/10.1177/0972262919855806

Shi, A. (2001). *Population Growth and Global Carbon Dioxide Emissions.* Washington, D.C : Development Research Group, The World Bank, .

Shrivastava, P., & Hart, S. (1995). Creating sustainable corporations. *Business Strategy and the Environment*, *4*(3), 154–165. https://doi.org/10.1002/bse.3280040307

Sorge, L., & Neumann, A. (2017). The Nexus of CO2 Emissions, Energy Consumption, Economic Growth, and Trade-Openness in WTO Countries. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3070087

Selden, T. M., & Song, D. (1995). Neoclassical Growth, the J Curve for Abatement, and the Inverted U Curve for Pollution,. *Journal of Environmental Economics and Management*, Volume 29,162-168,.

Sen, A. K. (1997). *On Economic Inequality*. Oxford, UK: Clarendon Press.

Smith, A. (1776). An Inquiry into the Nature and Causes of the Wealth of Nations. *London: Methuen & Co 1904 5th. Edition*.

Snowdon, B., & Vane, H. R. (2005). Modern Macroeconomics. *Edward Elgar Publishing, UK*, 585-586.

Solow, R. (1956). A Contribution to the Theory of Economic Growth",. *Quarterly J. of Economics,* , 70. 65-94.

Stern, D. I. (2004). The Rise and Fall of the Environmental Kuznets Curve. *World Development*, *32*(8), 1419–1439. https://doi.org/10.1016/j.worlddev.2004.03.004

Tandale, D. (2021). Caste, Economic Inequality, and Climate Justice in India. In G. MacNaughton, D. Frey, & C. Porter (Eds.), *Human Rights and Economic Inequalities* (1st ed., pp. 217–244). Cambridge University Press. https://doi.org/10.1017/9781009006545.009

Thormark, C. (2001). Conservation of energy and natural resources by recycling building waste. *Resources, Conservation and Recycling*, *33*(2), 113–130. https://doi.org/10.1016/S0921-3449(01)00078-7

Truby, J. (2018). Decarbonizing Bitcoin: Law and policy choices for reducing the energy consumption of Blockchain technologies and digital currencies. *Energy Research & Social Science*, *44*, 399–410. https://doi.org/10.1016/j.erss.2018.06.009

Ukaogo, P. O., Ewuzie, U., & Onwuka, C. V. (2020). Environmental pollution: Causes, effects, and the remedies. In *Microorganisms for Sustainable Environment and Health* (pp. 419–429). Elsevier. https://doi.org/10.1016/B978-0-12-819001-2.00021-8

Vogel, D. (1997). Trading up and governing across: Transnational governance and environmental protection. *Journal of European Public Policy*, *4*(4), 556–571. https://doi.org/10.1080/135017697344064

Wang, H., & Zhou, P. (2018). Assessing Global CO2 Emission Inequality From Consumption Perspective: An Index Decomposition Analysis. *Ecological Economics*, *154*, 257–271. https://doi.org/10.1016/j.ecolecon.2018.08.008

Wang, Q., & Zhou, Y. (2020). Evolution and drivers of production-based carbon emissions in China and India: Differences and similarities. *Journal of Cleaner Production*, *277*, 123958. https://doi.org/10.1016/j.jclepro.2020.123958

Wang, S. S., Zhou, D. Q., Zhou, P., & Wang, Q. W. (2011). CO2 emissions, energy consumption and economic growth in China: A panel data analysis. *Energy Policy*, *39*(9), 4870–4875. https://doi.org/10.1016/j.enpol.2011.06.032

Wang, Y., & He, X. (2019). Spatial economic dependency in the Environmental Kuznets Curve of carbon dioxide: The case of China. *Journal of Cleaner Production, 218,* 498–510. https://doi.org/10.1016/j.jclepro.2019.01.318

Wei, M., Patadia, S., & Kammen, D. M. (2010). Putting renewables and energy efficiency to work: How many jobs can the clean energy industry generate in the US? *Energy Policy*, *38*(2), 919–931. https://doi.org/10.1016/j.enpol.2009.10.044

Wright, G. (1997). Towards a More Historical Approach to Technological Change. *Economic Journal,*, pp.1560-1566.

Wolde-Rufael, Y., & Idowu, S. (2017). Income distribution and CO2 emission: A comparative analysis for China and India. *Renewable and Sustainable Energy Reviews*, *74,* 1336–1345. https://doi.org/10.1016/j.rser.2016.11.149

World Bank. (2013). *The World Bank Annual Report 2013*. The World Bank.

Xue, X., Liao, J., Hsing, Y., Huang, C., & Liu, F. (2015). Policies, Land Use, and Water Resource Management in an Arid Oasis Ecosystem. *Environmental Management*, *55*(5), 1036–1051. https://doi.org/10.1007/s00267-015-0451-y

Yang, B., Ali, M., Hashmi, S. H., & Shabir, M. (2020). Income Inequality and CO2 Emissions in Developing Countries: The Moderating Role of Financial Instability. *Sustainability*, *12*(17), 6810. https://doi.org/10.3390/su12176810

Yeo, Y., Shim, D., Lee, J.-D., & Altmann, J. (2015). Driving Forces of CO2 Emissions in Emerging Countries: LMDI Decomposition Analysis on China and India’s Residential Sector. *Sustainability*, *7*(12), 16108–16129. https://doi.org/10.3390/su71215805

You, W., Li, Y., Guo, P., & Guo, Y. (2020). Income inequality and CO2 emissions in belt and road initiative countries: The role of democracy. *Environmental Science and Pollution Research*, *27*(6), 6278–6299. https://doi.org/10.1007/s11356-019-07242-z

Zhang, X., & Wang, Y. (2017). How to reduce household carbon emissions: A review of experience and policy design considerations. *Energy Policy*, *102*, 116–124. https://doi.org/10.1016/j.enpol.2016.12.010

Zhou, Y., & Liu, Y. (2016). Does population have a larger impact on carbon dioxide emissions than income? Evidence from a cross-regional panel analysis in China. *Applied Energy*, *180*, 800–809. https://doi.org/10.1016/j.apenergy.2016.08.035

Zhuang, J., Kanbur, R., & Rhee, C. (2014). Rising Inequality in Asia and Policy Implications. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2399298

Appendix

Descriptive statistic India
Date: 05/22/23
Time: 20:56
Sample: 1980 2019

	CO2_IND	GDP_IND	REC_IND	FFE_IND
Mean	13.75662	27.12962	48.15697	61.04961
Median	13.73149	26.86225	49.41365	63.55418
Maximum	14.71417	28.67185	61.09510	73.67543
Minimum	12.86262	25.95076	32.41000	39.38335
Std. Dev.	0.584557	0.893446	10.48548	10.46430
Skewness	0.180997	0.400792	-0.239347	-0.493029
Kurtosis	1.756007	1.690524	1.499065	2.082424
Jarque-Bera	2.797597	3.928774	4.136586	3.023759
Probability	0.246893	0.140242	0.126401	0.220495
Sum	550.2647	1085.185	1926.279	2441.984
Sum Sq. Dev.	13.32656	31.13160	4287.870	4270.559
Observations	40	40	40	40

Descriptive statistic India continuation
Date: 05/22/23
Time: 20:58
Sample: 1980 2019

	TRA_IND	GINI_IND	IND_IND	POP_IND
Mean	29.94969	33.61375	27.69573	1.770411
Median	25.40443	33.29545	27.33661	1.835759
Maximum	55.79372	35.90000	31.13672	2.275893
Minimum	12.21927	31.70000	24.59646	1.025311
Std. Dev.	14.65967	1.372413	1.659456	0.403540
Skewness	0.359165	0.216111	0.772002	-0.304450
Kurtosis	1.651672	1.482562	2.768453	1.694466
Jarque-Bera	3.889976	4.149060	4.062603	3.458634
Probability	0.142989	0.125615	0.131165	0.177406
Sum	1197.988	1344.550	1107.829	70.81644
Sum Sq. Dev.	8381.326	73.45720	107.3980	6.350944
Observations	40	40	40	40

Descriptive statistic China
Date: 05/22/23
Time: 21:01
Sample: 1980 2019

	CO2_CHN	GDP_CHN	REC_CHN	FFE_CHN
Mean	15.20219	27.96471	24.94891	80.33481
Median	15.00668	27.77181	29.55106	79.62068
Maximum	16.18643	30.28988	36.56198	88.89836
Minimum	14.23737	25.97632	11.34000	68.38125
Std. Dev.	0.672334	1.449567	9.679507	6.896278
Skewness	0.184088	0.237378	-0.282159	-0.204685
Kurtosis	1.532428	1.645890	1.352115	1.648723
Jarque-Bera	3.815536	3.431675	5.056635	3.322554
Probability	0.148411	0.179813	0.079793	0.189896
Sum	608.0875	1118.588	997.9565	3213.392
Sum Sq. Dev.	17.62927	81.94851	3654.021	1854.787
Observations	40	40	40	40

Descriptive statistic China continuation
Date: 05/22/23
Time: 21:12
Sample: 1980 2019

	TRA_CHN	GINI_CHN	IND_CHN	POP_CHN
Mean	35.73692	36.91000	44.41041	0.933687
Median	35.82996	38.35000	45.07664	0.826904
Maximum	64.47888	43.70000	48.05769	1.610071
Minimum	12.42485	30.10000	38.58741	0.354741
Std. Dev.	14.78424	4.516350	2.478554	0.392358
Skewness	0.217775	-0.125896	-0.702982	0.308237
Kurtosis	2.131563	1.528632	2.540146	1.596084
Jarque-Bera	1.573144	3.713870	3.647001	3.918367
Probability	0.455403	0.156150	0.161460	0.140973
Sum	1429.477	1476.400	1776.416	37.34746
Sum Sq. Dev.	8524.377	795.4992	239.5859	6.003853
Observations	40	40	40	40

ADF unit root
Null Hypothesis: D(CO2_IND) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.343179	0.0001
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

ADF unit root
Null Hypothesis: D(GDP_IND) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.765441	0.0000
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

ADF unit root
Null Hypothesis: REC_IND has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.697170	0.0000
Test critical values:	1% level	-2.625606	
	5% level	-1.949609	
	10% level	-1.611593	

ADF unit root
Null Hypothesis: FFE_IND has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.086103	0.0002
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

ADF unit root
Null Hypothesis: D(TRA_IND) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.291348	0.0001
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

ADF unit root
Null Hypothesis: D(GINI_IND) has a unit root

Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.165944	0.0303
Test critical values:	1% level	-3.621023	
	5% level	-2.943427	
	10% level	-2.610263	

ADF unit root
Null Hypothesis: D(IND_IND) has a unit root
Exogenous: None
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.161608	0.0312
Test critical values:	1% level	-2.628961	
	5% level	-1.950117	
	10% level	-1.611339	

ADF unit root
Null Hypothesis: POP_IND has a unit root
Exogenous: None
Lag Length: 5 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.865356	0.0600
Test critical values:	1% level	-2.634731	
	5% level	-1.951000	
	10% level	-1.610907	

PP unit root
Null Hypothesis: D(CO2_IND) has a unit root
Exogenous: Constant
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.610863	0.0000
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

Null Hypothesis: D(GDP_IND) has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.792292	0.0000
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

Null Hypothesis: REC_IND has a unit root
Exogenous: None
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.779051	0.0004
Test critical values:	1% level	-2.625606	
	5% level	-1.949609	
	10% level	-1.611593	

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.630195	0.0006
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

Null Hypothesis: D(TRA_IND) has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.327793	0.0001
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

Null Hypothesis: D(GINI_IND) has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.844294	0.0000
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

Null Hypothesis: D(IND_IND) has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.407111	0.0001
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

Null Hypothesis: POP_IND has a unit root
Exogenous: None
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.289132	0.0001
Test critical values:	1% level	-2.625606	
	5% level	-1.949609	
	10% level	-1.611593	

ADF unit root
Null Hypothesis: D(CO2_CHN) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.085172	0.0362
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

ADF unit root
Null Hypothesis: D(GDP_CHN) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.717288	0.0077
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

ADF unit root
Null Hypothesis: D(REC_CHN) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.693428	0.0845
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

ADF unit root
Null Hypothesis: D(FFE_CHN) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.725390	0.0005
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

ADF unit root
Null Hypothesis: D(TRA_CHN) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.987013	0.0002
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

ADF unit root
Null Hypothesis: GINI_CHN has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.438748	0.0171
Test critical values:	1% level	-3.661661	
	5% level	-2.960411	
	10% level	-2.619160	

ADF unit root

Null Hypothesis: D(IND_CHN) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.038930	0.0033
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

ADF unit root
Null Hypothesis: D(POP_CHN) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.639340	0.0094
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

Null Hypothesis: D(CO2_CHN) has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.195563	0.0280
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.779364	0.0065
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

Null Hypothesis: REC_CHN has a unit root
Exogenous: None
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.111129	0.0349
Test critical values:	1% level	-2.625606	
	5% level	-1.949609	
	10% level	-1.611593	

Null Hypothesis: D(FFE_CHN) has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.826174	0.0004
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

Null Hypothesis: D(TRA_CHN) has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.043676	0.0002
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

Null Hypothesis: D(GINI_CHN) has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.486931	0.0138
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.042298	0.0032
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	

10% level	-2.609066	

Null Hypothesis: D(POP_CHN) has a unit root
Exogenous: Constant
Bandwidth: 6 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.419315	0.0164
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

Bound test India
F-Bounds Test IND   Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	49.14586	10%	1.92	2.89
K	7	5%	2.17	3.21
		2.5%	2.43	3.51
		1%	2.73	3.9

Bound test China
F-Bounds Test CHN   Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	39.36796	10%	1.92	2.89
k	7	5%	2.17	3.21
		2.5%	2.43	3.51
		1%	2.73	3.9

Dependent Variable: CO2_IND
Method: ARDL INDIA
Date: 05/23/23 Time: 00:20
Sample (adjusted): 1981 2019
Included observations: 39 after adjustments
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (0 lag, automatic): GDP_IND REC_IND FFE_IND
TRA_IND GINI_IND IND_IND POP_IND

Fixed regressors: C

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
CO2_IND(-1)	0.305148	0.147224	2.072674	0.0469
GDP_IND	0.139174	0.037192	3.742051	0.0008
REC_IND	-0.009479	0.003483	-2.721137	0.0107
FFE_IND	0.011431	0.002658	4.300184	0.0002
TRA_IND	0.002290	0.000941	2.432729	0.0212
GINI_IND	-0.026132	0.008794	-2.971499	0.0058
IND_IND	-0.013843	0.005548	-2.495178	0.0183
POP_IND	-0.199427	0.082268	-2.424128	0.0216
C	7.102628	1.790872	3.966017	0.0004

ARDL Error Correction Regression INDIA
Dependent Variable: D(CO2_IND)
Selected Model: ARDL(1, 0, 0, 0, 0, 0, 0, 0)
Case 2: Restricted Constant and No Trend
Date: 05/23/23 Time: 00:30
Sample: 1980 2019
Included observations: 39

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CointEq(-1)*	-0.694852	0.029356	-23.66987	0.0000

Dependent Variable: CO2_CHN
Method: ARDL CHINA
Date: 05/23/23 Time: 00:23
Sample (adjusted): 1981 2019
Included observations: 39 after adjustments
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (0 lag, automatic): GDP_CHN REC_CHN FFE_CHN TRA_CHN GINI_CHN IND_CHN POP_CHN
Fixed regressors: C

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
CO2_CHN(-1)	0.268349	0.137642	1.949614	0.0606
GDP_CHN	0.120821	0.048821	2.474766	0.0192
REC_CHN	-0.018213	0.002912	-6.255250	0.0000
FFE_CHN	0.023532	0.005426	4.336741	0.0002
TRA_CHN	-0.000556	0.001054	-0.527849	0.6015
GINI_CHN	-0.010556	0.003461	-3.049963	0.0048
IND_CHN	0.000466	0.002523	0.184834	0.8546
POP_CHN	-0.081847	0.037754	-2.167923	0.0382
C	6.787878	0.917366	7.399317	0.0000

ARDL Error Correction Regression CHINA
Dependent Variable: D(CO2_CHN)
Selected Model: ARDL(1, 0, 0, 0, 0, 0, 0, 0)
Case 2: Restricted Constant and No Trend
Date: 05/23/23 Time: 00:31
Sample: 1980 2019
Included observations: 39

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CointEq(-1)*	-0.731651	0.034537	-21.18478	0.0000

LONG RUNG COEFFICIENTS INDIA

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP_IND	0.200293	0.035712	5.608499	0.0000
REC_IND	-0.013641	0.003573	-3.817593	0.0006
FFE_IND	0.016451	0.001545	10.65020	0.0000
TRA_IND	0.003296	0.001346	2.448481	0.0204
GINI_IND	-0.037608	0.010603	-3.546930	0.0013
IND_IND	-0.019922	0.005410	-3.682686	0.0009
POP_IND	-0.287007	0.104136	-2.756084	0.0099
C	10.22178	1.215573	8.409024	0.0000

LONG RUN COEFFICIENTS CHINA

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP_CHN	0.165134	0.042024	3.929521	0.0005
REC_CHN	-0.024893	0.003035	-8.200979	0.0000
FFE_CHN	0.032163	0.006422	5.008009	0.0000
TRA_CHN	-0.000760	0.001421	-0.535119	0.5965
GINI_CHN	-0.014428	0.004010	-3.597972	0.0011
IND_CHN	0.000637	0.003408	0.186983	0.8529
POP_CHN	-0.111866	0.059148	-1.891287	0.0683
C	9.277475	1.078561	8.601718	0.0000

Breusch-Godfrey Serial Correlation LM Test: INDIA
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	0.049508	Prob. F(2,28)	0.9518
Obs*R-squared	0.137429	Prob. Chi-Square(2)	0.9336

Breusch-Godfrey Serial Correlation LM Test: CHINA
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	2.750395	Prob. F(2,28)	0.0942
Obs*R-squared	6.403753	Prob. Chi-Square(2)	0.0812

Pairwise Granger Causality Tests INDIA
Date: 05/23/23 Time: 18:22
Sample: 1980 2019
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
GDP_IND does not Granger Cause CO2_IND	38	1.63093	0.2111
CO2_IND does not Granger Cause GDP_IND		1.13947	0.3323
REC_IND does not Granger Cause CO2_IND	38	0.25361	0.7775
CO2_IND does not Granger Cause REC_IND		2.63829	0.0865
FFE_IND does not Granger Cause CO2_IND	38	1.27841	0.2919
CO2_IND does not Granger Cause FFE_IND		0.24799	0.7818
TRA_IND does not Granger Cause CO2_IND	38	9.16337	0.0007
CO2_IND does not Granger Cause TRA_IND		0.22408	0.8005
GINI_IND does not Granger Cause CO2_IND	38	4.48162	0.0190
CO2_IND does not Granger Cause GINI_IND		1.63516	0.2103
IND_IND does not Granger Cause CO2_IND	38	12.8176	8.E-05
CO2_IND does not Granger Cause IND_IND		1.90883	0.1643
POP_IND does not Granger Cause CO2_IND	38	1.69272	0.1996
CO2_IND does not Granger Cause POP_IND		0.58149	0.5647
REC_IND does not Granger Cause GDP_IND	38	3.94971	0.0290
GDP_IND does not Granger Cause REC_IND		0.77589	0.4685
FFE_IND does not Granger Cause GDP_IND	38	1.12743	0.3360
GDP_IND does not Granger Cause FFE_IND		0.02003	0.9802
TRA_IND does not Granger Cause GDP_IND	38	1.33111	0.2780
GDP_IND does not Granger Cause TRA_IND		11.0173	0.0002
GINI_IND does not Granger Cause GDP_IND	38	1.90619	0.1647
GDP_IND does not Granger Cause GINI_IND		1.24804	0.3003
IND_IND does not Granger Cause GDP_IND	38	3.81798	0.0322

GDP_IND does not Granger Cause IND_IND		5.16979	0.0111
POP_IND does not Granger Cause GDP_IND	38	4.77851	0.0150
GDP_IND does not Granger Cause POP_IND		0.36295	0.6984
FFE_IND does not Granger Cause REC_IND	38	4.49812	0.0187
REC_IND does not Granger Cause FFE_IND		0.28230	0.7558
TRA_IND does not Granger Cause REC_IND	38	2.05072	0.1447
REC_IND does not Granger Cause TRA_IND		0.18089	0.8353
GINI_IND does not Granger Cause REC_IND	38	0.51077	0.6047
REC_IND does not Granger Cause GINI_IND		2.32712	0.1134
IND_IND does not Granger Cause REC_IND	38	3.41735	0.0448
REC_IND does not Granger Cause IND_IND		1.69545	0.1991
POP_IND does not Granger Cause REC_IND	38	2.90378	0.0689
REC_IND does not Granger Cause POP_IND		1.92845	0.1614
TRA_IND does not Granger Cause FFE_IND	38	2.78022	0.0766
FFE_IND does not Granger Cause TRA_IND		0.93272	0.4036
GINI_IND does not Granger Cause FFE_IND	38	0.32698	0.7234
FFE_IND does not Granger Cause GINI_IND		2.95330	0.0661
IND_IND does not Granger Cause FFE_IND	38	5.43498	0.0091
FFE_IND does not Granger Cause IND_IND		1.03962	0.3649
POP_IND does not Granger Cause FFE_IND	38	0.45524	0.6382
FFE_IND does not Granger Cause POP_IND		0.81873	0.4497
GINI_IND does not Granger Cause TRA_IND	38	5.24878	0.0105
TRA_IND does not Granger Cause GINI_IND		0.62007	0.5441
IND_IND does not Granger Cause TRA_IND	38	1.85585	0.1723
TRA_IND does not Granger Cause IND_IND		1.57233	0.2227
POP_IND does not Granger Cause TRA_IND	38	0.13100	0.8777
TRA_IND does not Granger Cause POP_IND		4.25678	0.0227
IND_IND does not Granger Cause GINI_IND	38	0.61146	0.5486
GINI_IND does not Granger Cause IND_IND		3.84294	0.0316
POP_IND does not Granger Cause GINI_IND	38	1.99189	0.1525
GINI_IND does not Granger Cause POP_IND		1.35732	0.2713
POP_IND does not Granger Cause IND_IND	38	2.66533	0.0845
IND_IND does not Granger Cause POP_IND		1.36104	0.2704

Pairwise Granger Causality Tests CHINA
Date: 05/23/23   Time: 18:24
Sample: 1980 2019

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
GDP_CHN does not Granger Cause CO2_CHN	38	0.23891	0.7888
CO2_CHN does not Granger Cause GDP_CHN		8.37353	0.0011
REC_CHN does not Granger Cause CO2_CHN	38	1.13311	0.3342
CO2_CHN does not Granger Cause REC_CHN		0.51837	0.6003
FFE_CHN does not Granger Cause CO2_CHN	38	2.33396	0.1127
CO2_CHN does not Granger Cause FFE_CHN		2.27082	0.1191
TRA_CHN does not Granger Cause CO2_CHN	38	4.45052	0.0194
CO2_CHN does not Granger Cause TRA_CHN		3.53867	0.0405
GINI_CHN does not Granger Cause CO2_CHN	38	5.94880	0.0062
CO2_CHN does not Granger Cause GINI_CHN		0.57580	0.5678
IND_CHN does not Granger Cause CO2_CHN	38	0.18629	0.8309
CO2_CHN does not Granger Cause IND_CHN		2.54439	0.0938
POP_CHN does not Granger Cause CO2_CHN	38	3.76015	0.0338
CO2_CHN does not Granger Cause POP_CHN		1.38552	0.2644
REC_CHN does not Granger Cause GDP_CHN	38	4.03101	0.0271
GDP_CHN does not Granger Cause REC_CHN		0.43580	0.6504
FFE_CHN does not Granger Cause GDP_CHN	38	6.11943	0.0055
GDP_CHN does not Granger Cause FFE_CHN		0.09884	0.9062
TRA_CHN does not Granger Cause GDP_CHN	38	3.79809	0.0328
GDP_CHN does not Granger Cause TRA_CHN		3.65949	0.0367
GINI_CHN does not Granger Cause GDP_CHN	38	2.72275	0.0805
GDP_CHN does not Granger Cause GINI_CHN		0.37337	0.6913
IND_CHN does not Granger Cause GDP_CHN	38	3.72627	0.0347
GDP_CHN does not Granger Cause IND_CHN		1.21842	0.3087
POP_CHN does not Granger Cause GDP_CHN	38	2.43584	0.1031
GDP_CHN does not Granger Cause POP_CHN		1.51965	0.2337
FFE_CHN does not Granger Cause REC_CHN	38	2.16144	0.1312
REC_CHN does not Granger Cause FFE_CHN		3.55682	0.0399
TRA_CHN does not Granger Cause REC_CHN	38	6.30266	0.0048
REC_CHN does not Granger Cause TRA_CHN		3.42022	0.0447
GINI_CHN does not Granger Cause REC_CHN	38	8.26019	0.0012
REC_CHN does not Granger Cause GINI_CHN		0.82390	0.4475
IND_CHN does not Granger Cause REC_CHN	38	0.15291	0.8588
REC_CHN does not Granger Cause IND_CHN		3.11260	0.0578
POP_CHN does not Granger Cause REC_CHN	38	3.99964	0.0278
REC_CHN does not Granger Cause POP_CHN		0.45510	0.6383

TRA_CHN does not Granger Cause FFE_CHN	38	1.61643	0.2139
FFE_CHN does not Granger Cause TRA_CHN		4.49163	0.0188
GINI_CHN does not Granger Cause FFE_CHN	38	4.00818	0.0276
FFE_CHN does not Granger Cause GINI_CHN		0.18251	0.8340
IND_CHN does not Granger Cause FFE_CHN	38	0.99097	0.3820
FFE_CHN does not Granger Cause IND_CHN		1.47611	0.2432
POP_CHN does not Granger Cause FFE_CHN	38	3.03992	0.0614
FFE_CHN does not Granger Cause POP_CHN		2.37087	0.1091
GINI_CHN does not Granger Cause TRA_CHN	38	2.87935	0.0704
TRA_CHN does not Granger Cause GINI_CHN		2.09708	0.1389
IND_CHN does not Granger Cause TRA_CHN	38	0.91341	0.4111
TRA_CHN does not Granger Cause IND_CHN		0.76046	0.4755
POP_CHN does not Granger Cause TRA_CHN	38	1.38140	0.2654
TRA_CHN does not Granger Cause POP_CHN		0.63142	0.5381
IND_CHN does not Granger Cause GINI_CHN	38	0.56549	0.5735
GINI_CHN does not Granger Cause IND_CHN		1.12981	0.3353
POP_CHN does not Granger Cause GINI_CHN	38	2.28911	0.1172
GINI_CHN does not Granger Cause POP_CHN		1.17976	0.3200
POP_CHN does not Granger Cause IND_CHN	38	0.57485	0.5683
IND_CHN does not Granger Cause POP_CHN		0.90970	0.4125

NEXUS AMONG CO2 EMISSIONS, TRADE OPENNESS, INCOME INEQUALITY, RENEWABLE ENERGY, NON-RENEWABLE ENERGY, AND ECONOMIC GROWTH. A COMPARATIVE ANALYSIS IN CHINA AND INDIA

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07.03.2023

Dear Yusifu Conteh

Your project **"Nexus among trade openness, CO2 emissions, income inequality, renewable energy, non-renewable energy, and economic growth. A comparative analysis between two Asian giant economies China and India"** has been evaluated. Since only secondary data will be used the project does not need to go through the ethics committee. You can start your research on the condition that you will use only secondary data.

Prof. Dr. Aşkın KİRAZ

The Coordinator of the Scientific Research Ethics Committee