IMPACT OF INCOME INEQUALITY AND POPULATION DENSITY ON CARBON EMISSION IN PAKISTAN

BY

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ABSTRACT

The world has been facing crises of social, global and environmental. This study is relating to the environmental degradation. Current study inspects the effect of income disparity and population density along with urban population, GDP square and per capita GDP on the emissions of carbon in the case study of Pakistan. For such purpose, the approach of ARDL bounds testing used for the data from year 1985 to 2020. Data collected from different sources, including World Bank (WB) and World Inequality Database (WID). Empirical results for the carbon emissions confirm the presence of long run co-integration relation amid population density and income inequality. The outcomes of this study specify that there is direct relationship of carbon emission with income inequality, population density, GDP and urban population. The estimated results specify that as the income inequality rise in Pakistan, the emission of carbon also rises. This study also confirm that as the population density increases it will increase the carbon emissions. By applying Breusch-Godfrey Serial Correlation LM Test, we conclude that there is no existence of serial correlation in the data. CUSUM and CUSUMSQ specify that the parameters are stable. The empirical outcomes of this study offer policy implications to confirm the policy of distributive and make distribution of income equal to attain stability of economy and control CO2 emissions and implement improvement of detail policy in Pakistan that can control the growth of population.

Keywords: Environmental degradation, population density, income inequality, carbon emission, Autoregressive Distributed Lag (ARDL), Pakistan.

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LIST OF ABBREVIATIONS

GDP – Gross Domestic Product

GHG – Greenhouse Gas

CO2 – Carbon dioxide

ADF – Augmented Dicky Fuller Test

ARDL - Autoregressive distributive lag

WB - World Bank

WID – World Inequality Database

CUSUM - Cumulative Sum

CUSUMSQ – Cumulative Sum of Square

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CHAPTER 1

INTRODUCTION

1.1. Background

Environmental degradation has been subject to extensive debate and thus has received a wide attention. Several studies have analyzed the environmental degradation and its association with other economic variables. Recently, the role of income inequality as determining factor for the environmental degradation has been the major issue of concern among researchers. Income inequality also has been presented to be quite persistent phenomenon in both developed and developing countries (Baloch et al., 2017). Income inequality has become a critical issue that has enlarged the attention of research (Uzar & Eyuboglu, 2019). The many social and economic classes in the society are being negatively impacted by a rising trend of income inequality. The poor and underprivileged societies are seriously affecting by the distribution of an unbalanced income, meanwhile, they are mainly a susceptible portion of the society (Khan & Yahong, 2021). In this framework, considering the effects of income disparity on emissions of carbon but neglecting population density is an essential lack in environmental studies. The extended gap of income which tend to high carbon emissions by generating hurdles in the path of policies of environment (Khan & Yahong, 2021). There are many possible clarifications for the relation amongst the inequality of income and degradation of environment. In Pakistan, poor people do whatsoever it takes to acquire what they actually need, even if it means in the procedure to producing damage to the environment. As an illustration, to meet their specific requirements, abundant natural resources are being utilized (Sarkar et al., 2018). Due to the deficiency of resources of education in the countries of limited budget, fossil fuels and other waste of food can be used to produce natural resources and individuals are dependent on those natural resources in these regions. Because they have minimal entree to the sources of renewable energy, advance technologies and the measures for the protection of environment (Tanchangya & Zhou Ayoungman, 2022).

Population density is defined as a measurement of population per unit area (square mile or per square kilometer). It is a basic geographical term. Higher population density has definitely empowered the social and economic development, but higher population density increases the carbon dioxide emissions (Rahman et al., 2020). The population that exist globally surpasses seven billion and is expecting to touch nine billion by 2050 and the population that exist globally is growing by around 80 million according to recent United Nations estimates — the size of Germany — each year (Sikdar et al., 2016).

In latest years, the inequality of income has supposed to affect the carbon emissions and in academic circles and the consideration of policy, this has become a huge issue (Baloch et al., 2018). CO2 emissions tend to keep increasing day by day with income. Importantly, the relation amid the degradation of environment and income inequality has ignored in mainstream of developing countries, Pakistan is also including in such countries. The mostly studies have attentive mainly on many industrialized countries, and the empirical studies on the emerging and developing economies such as Pakistan, almost non-available to the level of our information (Baloch et al., 2017).

No doubt in global warming, the growth of human population is a major contributor, given that to power their increasingly mechanized lifestyles, humans use fossil fuels. If there are more people then there are more demand for gas, oil, coal and other fuels drilled or mined from underground the surface of the Earth that, when burned, emit large amount of CO_2 into the atmosphere. More people means more transportation and transportation sector generates the largest share of oil that related to the emissions of carbon dioxide (CO2). Energy considered as the driving force for the development of an economy and a numerous researchers have claimed that the core reason of increased carbon emissions is the increasing carbon emissions, thus resulting in the degradation of environment hence, all over the world the change in climate and its influence has been a rising concern (Islam et al., 2017). From transportation, the emissions of CO2 originate from burning of fossil fuel for our trucks, cars, ships, planes and trains. Coal, petroleum, oil, and gas combustion are examples of human behaviors, as well as cutting of forests in the country have greatly enlarged the attentions of carbon emissions in the atmosphere and from the use of fossil fuels, almost all carbon emissions (about 96.5%) come (Hassan et al., 2015). Therefore, population density is a major cause of CO2 emissions.

The world has been facing crises of global social and environmental. Expanding of economic disparity is between the social crises that has been facing by many countries in this world and the crises of environment has exposed in the speedy increase in the pressure of environment (Baloch, et al., 2020). Levels of carbon dioxide are higher today. From the past several years, Pakistan as well as other emerging countries that have continued to post a significant upsurge in degrading the environment in the form of carbon emanations and to the condition of the environment it has postulated very severe fears (Khan & Yahong, 2021). The concentrations of carbon CO_2 are mostly growing due to the use of fossil fuels that people are burning in the form of gas, petrol and coal for energy. These fossil fuels contain carbon that plants make through photosynthesis that selected from the atmosphere over the duration of numerous millions of years. Related to historical differences in energy consumption, fossil fuel that caused global warming may worsen the inequality of economy (Yang et al., 2021). In Pakistan, the contribution to the emissions of greenhouse gasses is not very substantial, but the emissions of carbon has been growing harshly, due to which it become the key problem to the degrading the environment (Khan & Yahong, 2021). CO_2 emissions are different in developed as well as developing countries. Degradation of environment has been subject to widespread debate due to which it has received a huge attention (Baloch et al., 2017). Increasing the degradation of environment in the form of carbon dioxide emissions, for many countries it is a key threat to the environmental quality and for the sustainable development (Khan & Yahong, 2021). The deterioration of environment has touched levels of alarming situation and that has elevated concerns for the climate change and for the global warming. As a result, in recent years understanding about reasons for degrading the environment and its association with the growth of economy that has become progressively important (Khoshnevis & Dariani, 2019).

Source of CO_2 emissions in developing nations is due to higher population, not just total population but also due to population density. Because poor people utilize more fossil fuels for cooking or heating purposes and due to which they emit more carbon in the society. On the other side, in emerging countries, resources are not distributing equally. Resources are urban focused while rural area is being neglect in developing countries. Even in urban areas of developing countries like Pakistan, urban sprawl is enjoying more resources than lower income group who lives in kachi abadi. Moreover, these lower income classes confined to live in a densely populated area, and they cannot afford large houses and more resources. In urban areas, elite class is using more resources than lower class. Apart from inequality for an economy, the consumption that created accounting of carbon emissions that is significantly undervalue due to leakages of carbon internationally, that arouse concerns for the historical and regional disparity of carbon emanations consequently, it is essential to share responsibilities of carbon emission among consumers and producers to encourage a global climate policy (Yang et al., 2021). In the twenty-first century, income inequality and change in climate both are the key unsettled challenges that are facing by humankind (Uddin et al., 2020)

Income inequality is defined, as the income that is generating in a country cannot fairly distributed among regions, individuals or social classes (Uzar & Eyuboglu, 2019). Income inequality is how unevenly distribution of income throughout a population. If distribution of income is less equal, it means higher the income inequality and vice versa. According to the report of UNDP of Pakistan National Human Development Report 2020 prominence, that Pakistan is divide into two halves, one for the richest people and the other for the poorest people that result in immense level of income disparity.

Developing countries are trapping in multidimensional problems. Among all, environmental degradation is an emerging problem and CO_2 emissions are increasing day by day. Degradation of environment is a procedure by which the natural environment is compromising in some way, decreasing the diversity of biology and the health of the environment and this procedure can be totally natural in origin, or it can be enhanced by the activities of human (Hassan et al., 2015). Economically, South Asia is less emerging in the world; it is one of the poorest regions. Many emerging countries of South Asia face income inequality, absolute poverty, growth of population, and the degrading the environment (Khan & Yahong, 2021). According to the reports of World meter 2022, in the world, it is on number five among the most populous countries, with a population that exceeding 225.2 million. In the list of countries by population, Pakistan ranks number 5. The population density is 287 per Km^2 in Pakistan (742 people per mi^2). Pakistan is also facing serious types of global social and environmental crises, in 2008 the emissions of greenhouse gases were about 147.8 million tons of CO_2 equivalent (Shaikh and Tunio, 2015). In 2016, in

Pakistan CO_2 emissions were 178,013,820 tons that is share of World's carbon dioxide CO_2 emissions was 0.50% and now increase to 1%. Carbon dioxide CO_2 emissions have quickly increased in last few decades. Throughout the last few years, Pakistan nonstop to post significant upsurge in the emanations of carbon and has apparently posited some severe fears to the environment (Baloch et al., 2017)

The tasks and problems for the environment of Pakistan are connecting mainly with an unfair economic and social development from the latter two to three decades and due to a transferal of population to urban areas from rural areas, this task is further compound with speedy urbanization (Hassan et al., 2015). Pakistan is facing many severe problems about the degradation of environment with the higher consumption of energy (Khan & Yahong, 2021). Generators, motor vehicles, cooking and heating fuels and many more, are some of the sources of the level of household that emit carbon dioxide CO2 at large scale in urban residential centers. Improvement in the lifestyle of cities has changed the forms of consumption for energy and for fuel. Urban sprawl and the growth of population are the key reason of upsurge in the need of vehicles domestically, which also caused growth in the volume of traffic (Khan et al., 2017). In an economy, the population density might have important recommendation for the level of pollution of that nation (Ohlan, 2015). Chief features that causing degradation to the quality of air, main factors causing are, firstly the demand for quickly growing energy and secondly a faster developing of transport sector. Folks who reside in locations where air, soil, and water contamination are abundant can suffer from a variety of health complications. Extensive usage of low-quality fuel in the cities, on roads a mutual with a dramatic progress in the number of automobiles, has headed to substantial the problem of air pollution and the levels of air pollution in the utmost populous cities of Pakistan are climbing and high producing severe problems of health (Hassan et al., 2015).

As upsurge in the income of household can have a direct result on the intake of services and goods that are consuming by household individuals, inequalities of carbon emissions and energy demand may present among household individuals with diverse levels of income (Junjie et al., 2017). Greater disparity of income can hypothetically worsen the degrading of environment because when the inequality of income is greater, it is argued that the needy people tend to spoil resources of nature. Moreover, when there exist higher income inequality in the societies, then rich people have a tendency to have a strong consequence over policymaking (Uddin et al., 2020). Grunewald et al. (2017) revealed that for low-income economies and economies of middle-income, higher inequality of income linked with lesser emanations of carbon, and in upper middle-income and high-income economies, greater inequality of income connected with greater emanations of carbon dioxide (CO2).

The society of Pakistan consist of three segments rich, middle and poor and the emission of carbon dioxide is different among these three segments. Contribution of poor along with rich people, to the misappropriation of resources that are natural and degrading the environment, but the people that are rich become fewer pretentious than the poor because people that are poor are appearance upon as sufferers in addition to representatives of degrading the environment. Rapid urbanization increases the environmental degradation. In Pakistan, there is a speedy urbanization because a shifting of inhabitants to urban areas from rural areas. Urbanization and high densities of urban areas were expecting in latest decades, due to globalization of an economy, many developing or emerging countries are undergoing the transformation of an economy that eventually leads to the physical enlargement of urban areas. Nevertheless, over the last few decades, the speedy wave of urbanization has realized the potential for the demand of increased energy and concerns for severe environment, instantaneously (Khoshnevis & Dariani, 2019). Leading to rise in pollution, all major cities face unplanned and random growth. Extensive usage of low-quality fuel and mutual with a dramatic enlargement in the number of automobiles on roads in the cities, has led to significant the problems of air pollution due to which the level of air pollution in most populous cities of Pakistan are climbing and high producing the serious problems of health (Hassan et al., 2015). It is highly debatable that combustion byproducts fossil fuels and depleting natural resources for the beneficial for an economy will likely upsurge the life quality of inhabitants, it is important to remember that any endeavor to release hazardous toxin pollutants into the environment will hinder humanity's and species' lifestyle either now or in the years ahead (Ameyaw & Yao, 2018).

In Pakistan, the majority of the population drives outdated model cars, and people do not pay attention to their regular maintenance, resulting in pollution in the cities. Because heavy vehicles consume a lot of diesel, they emit a lot of carbon. Companies and industries are relying on ancient, heavy automobiles that are not properly maintain, resulting in carbon emanations. Because industries are concentrated in cities, all heavy automobiles arrives in the cities for the purpose of transportation there and thus responsible for worsens the environment's poor quality. Automobiles do not all have the same influence on the environment. There are no direct emanations from electric motor automobile exhaust. However, when they prepared and charged using power generated from the resources of non-renewable such as coal, natural gas, and oil, they produce pollutants indirectly. Traditional gasoline or diesel automobiles emit the most direct pollutants, albeit not all automobiles emit the same amount. Individuals from the wealthy can purchase newer models or electric cars, whilst those from the poor can only afford old cars. In this way, the poor circle is the primary source of carbon emissions. Pollutants discharged into the environment by fossil fuels have enhance the amount and usage of renewable energies. Nonetheless, protecting the environment from the emanations of carbon has ascended to the top of the priority list for most of the economies throughout the world and Worries about the change in climate and global warming are upsurge by the prospect of eliminating or strong diminishing the emissions of carbon, primarily from the greenhouse gases (GHG) emanations (Ameyaw & Yao, 2018). Poor air quality can be generated by dumping of toxic areas, traffic congestion, and public transportation. Respiratory ailments, such as asthma, may be prevalent in staggering numbers amongst citizens.

Growth in the economy is define as an upsurge in actual output (real GDP). Consequently, higher yields and usage are able to trigger in environmental consequences. Offers a higher of non - renewable sources, up surged pollution, expanding temperatures, and the potential damage of environmental ecosystems are all manifestations of the environmental consequences of economic expansion. Dust storms are a very obvious and evident risk, but the consequences of growing emanations of pollutant are less obvious, thus, governments have less motivation to address them. Quality of poor air and smog in Lahore are cause by industrial pollutants, smoking from brick kilns and cars, grain crops burning, and general garbage, it has an influence on the entire city. It is harmful to the health for the residents.

In cities, there are numbers of electricity appliances and vehicles of domestic usage upsurge by the variation of behavior and lifestyles of the people. It might be considered as an enhancing the standard of living for the urban areas but this random and unplanned development eventually outcomes in severe threat to Industrial activities and global climate and transport automobiles are also playing main role in the emanations of greenhouse gas (GHG) (Khan & Yahong, 2017). All the above factors can create heat island. A structure that consist of roads, buildings and other infrastructure that re-emit and absorb the heat coming from the sun more than rural areas where there are unlimited greenery and natural landscapes. Mostly, urbanized areas are heat islands because of buildings, congested roads and lack of greenery and limited landscapes. In urban areas, there exist different classes of the society that consist of rich class, middle class and poor class. Improvement in lifestyle of urban areas has altered the pattern of consumption for fuel and energy. In Pakistan, speedy population explosion, weak governance, dishonesty, extraction of natural resources, high reliance on fossil fuels for power generation and inadequate enforcement of laws are all common difficulties and issues (Uzair Ali et al., 2022). Carbon emissions vary from one segment of the society to another segment of the society and from one locality to another locality. There are numerous studies conducted on the emissions of greenhouse gas (GHG) and its influence on climate change everywhere in the world (Khan et al., 2017). However, in Pakistan current study on the poor segment of the society carbon emissions is neglecting up to now.

1.2 Research Gap

According to the widely regarded BP Energy (2021) statistics evaluation of World Energy, countries with a high population density were responsible for 52% of worldwide carbon dioxide emissions in the previous year 2020. The main cause of high GHG emissions is the increasing energy demand in transportation brought on by a large population. About 24% of the world's CO2 emissions are attributable to the transportation industry, with road transportation contributing the most. In order to examine the effects of income inequality and population density on carbon emissions, we have chosen Pakistan because it is a country with a high population density. Only a few studies have looked into how population density and wealth disparity affect carbon emissions.

Empirical studies (discussed below) have inspected the effect of income disparity on the quality of environment in both developed and emerging countries, but no definite conclusion could be produced. Grunewald et al. (2017), analyzed theoretically ambiguous link amongst the emissions of per capita carbon dioxide (CO2) and inequality of income. He concluded that for economies of low-income and economies of middle-income, higher inequality of income is linked with lower emissions of carbon whereas in economies of upper middle-income or high-income, per capita emissions increases by the higher inequality of income. Jorgenson et al. (2017), analyze the relation among carbon emissions of state-level in US and two measures of inequality of income: the Gini coefficient and the share of income for the top ten percent. Also concluded that state-level emanations are directly connected with the share of income for the top ten percent, whereas the consequences of the Gini coefficient are non-significant on the emanations of carbon. Baloch et al. (2020), evaluate the linkage among the emissions of carbon dioxide, income inequality and poverty for the countries of 40 Sub-Saharan African and estimated that increased inequality of income contributes to emissions of CO2. Furthermore, a rise in poverty has a harmful consequence on the pollution of environment in the countries of Sub-Saharan African. Mushtaq et al. (2020), shows the influence of growth of an economy and disparity of income on the emissions of carbon dioxide by the controlling role of innovation in China at regional levels and national levels and concluded that as there is a rise in the gap of income then emissions of carbon also rise. Improvement not only has a direct consequence on the emissions of carbon but also controls the relation of emissions of carbon and the inequality of income at the national level and the regional level.

According to above discussion, most of the outcomes are “ambiguous” with no observed indication that usually support the hypothesis. Wang et al. (2021), which found income disparity, population density and poverty influencing CO2 emissions. As it can be observed, that in some societies, poor contribute more CO2 and, in some societies, upper class contribute more to carbon emissions. The impacts of the consumption at household level with growing income and the households with highest-income emit 1.8 times more CO2 as compared to the lowest-income ones (Junjie et al., 2017). The primary motive of this study is to evaluate Pakistan's high population density and income disparity influence on the emanations of carbon from 1985 to 2020. Despite the fact that recent literature delivers useful visions about income inequality and population density on carbon emissions, we were incapable to locate any prominent research for Pakistan that looked into the role of income inequality and population density on CO2 emissions. As a result, more research is essential to deliver new and more final conclusions. To our information, there hasn't been any study in Pakistan on how the low-income contributors and urban population affect the carbon emissions in Pakistan. As a result, this study aims to fill a gap in the literature by evaluating the impact of low-income contribution and the role of urban population in the case study of Pakistan.

After a complete assessment and review of literature, this study highlighted Wang et al. (2021), which found income disparity, size of population and poverty relationship on the emissions of CO2. However, in Pakistan the dynamics of CO2 emissions are different. For low-income class and middle-income class, greater the inequality of income interconnected with lesser emissions of carbon whereas in upper middle class and the class of higher income, per capita emissions surges by greater the inequality of income (Grunewald et al., 2017). Jorgenson et al. (2017) found a direct connection amongst income disparity and the emissions of carbon dioxide (CO2) when inequality of income measured in the form of wealth of top 10%, whereas there was no connection among income disparity and the emanations of carbon dioxide (CO2), when the inequality of income measured by using the Gini coefficient. Junjie et al. (2017) conducted a study in China and estimated that with growing income, the impact of household consumption is strengthened, and the highest-income households had 1.8 times more CO2 emissions as compared to the lowest-income ones.

Current study is different from other studies in Pakistan. Current research contributes to the literature by emphasizing that poor and low-income groups contributes more to the emanations of carbon. Therefore, current study is the first study that inspects the relation among income disparity, population density along with urban population and GDP per capita on the emanations of carbon dioxide (CO2) in Pakistan. Current study in Pakistan on the poor segment of the society carbon emissions is neglecting up to now.

1.3 Research Questions

Current study attempts to resolve the key research question:

1. Who is responsible for CO2 emissions (lower or upper-income group) in a densely populated country like Pakistan?

The present research attempted to provide answers to this issue by aiming to inspect the connection amongst income inequality and density of population together with the consequences of urban population and the gross domestic product GDP on the emanation of carbon (CO2).

1.4 Research Objectives

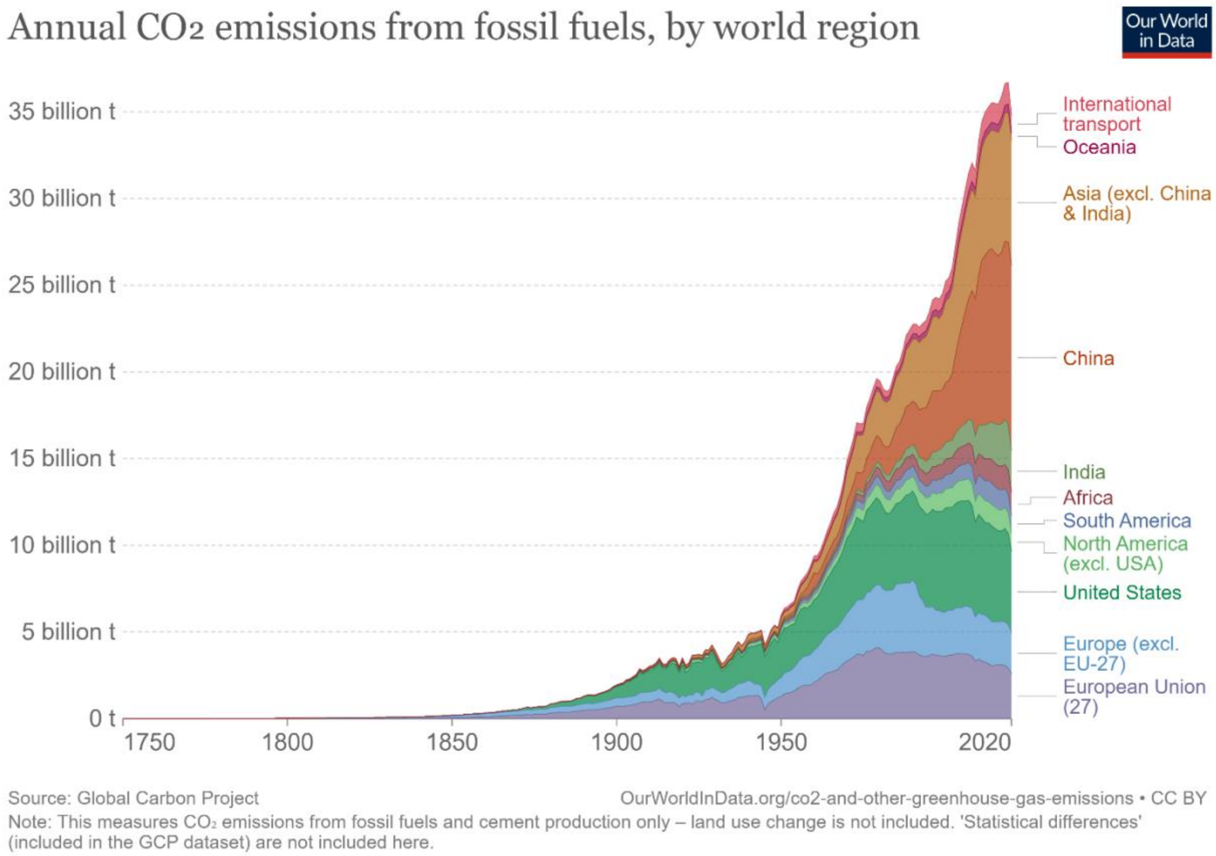
Objective is a content or direction of a research investigation. Objective of this paper is as follows.

1. To evaluate the contribution of upper and lower-income group in CO2 emissions for densely populated country like Pakistan.

1.5 Significance of the study

After a complete assessment and review of literature, this study found Wang et al. (2021), which highlighted the impact of income disparity, size of population and poverty on the emissions of CO_2. However, in Pakistan the dynamics of CO_2 emissions are different. For low-income class and middle-income class, greater the inequality of income interconnected with lesser emissions of carbon whereas in upper middle class and the class of greater income, per capita emissions surges (Grunewald et al., 2017). Jorgenson et al. (2017) found a direct connection amongst income disparity and the emissions of carbon dioxide (CO2) when inequality of income measured in the form of wealth of top 10%, whereas there was no connection among income disparity and the emanations of carbon dioxide (CO2), when the inequality of income measured by using the Gini coefficient. Junjie et al. (2017) conducted a study in China and estimated that with growing income, the impact of household consumption are strengthened, and the highest-income households had 1.8 times more CO2 emissions as compared to the lowest-income ones.

Current research contributes to the literature by emphasizing that developing countries like Pakistan contributes more to the emanations of carbon due to the reason that size of lower income group is so large as compared to upper income group. According to the World Bank statistics upper income group consist of 0.6% while lower income group consist of 43.9%. This study plays an important role for better understanding of carbon dioxide CO_2 emissions by examining the influence of income inequality and population density among different sectors in Pakistan. Not only income inequality contributes towards emissions rather due to increased population as well as increased population density, but CO2 emissions can also be high. Urbanization is the main reason of population density. In cities, there are congested area of huge population and due to which energy demand increases. Therefore, current study is the first study that inspects the relation among income disparity, population density along with urban population and GDP per capita on the emanations of carbon dioxide (CO_2) in Pakistan.



Historically industrialized or developed countries were the hotspots for carbon emissions. But now they have controlled their carbon emissions and their emissions are declining as well. Currently, Asia is the hotspots for carbon emissions such as India, Pakistan, and China. Pakistan is not industrialized country as such, but the reason is densely populated country, urbanization and poverty. Khan & Yahong (2021), according to this study carbon emissions in Pakistan are rising day by day.

1.6 Plan of the study

The entire study is divided into five sections, including Chapter 1, Introduction, Chapter 2, Review of the Literature that provides a brief summary of literature on the impact of income inequality and population density on carbon emissions. Chapter 3, Methods and Techniques, Chapter 4, the Empirical Finding and its justification that reports the estimated results and discussions while last Chapter 5, that is consist of Current Study's Conclusion and policy implications.

CHAPTER 2

Literature Review

A literature review intend to understand the current study and discussions that are pertinent to specific subject or field of the study. The present research empirically evaluates the connotation amongst income disparity and density of population, sideways with the per capita GDP and the urban population on the emissions of carbon in Pakistan. The examination of disparity of income together with the density of population and other indicators of an economy on the emanations of carbon prolonged and fascinated the curiosity of the investigators. Nevertheless, the examination of disparity of income sideways with degrading the environment has not been recognize with adequate deliberation and consequently it arrives as an incipient and warm research occurrence in the experiential literature. Current portions deliberate previously theoretical literature on, in addition to detailed literature from preceding research and the research gap.

Choi et al. (2010), examine the presence of the Environmental Kuznets curve (EKC) for the emanations of carbon and its causal relation with openness and the growth of economy. Current study is using the data of time series from the period of 1971-2006 of China, which is an emerging market, Korea is a country that is a recently industrialized and Japan that is an established country. China shows an N-shaped curve of Environmental Kuznets Curve (EKC) while Japan shows a U-shaped Environmental Kuznets Curve (EKC). Current study shows the dynamic relation among the variables by implementing a model of vector auto regression or a Vector Error Correction Model (VECM). Such procedures through the instinct response functions permit for examination of the causal effect of variables on the dynamic reaction of emanation variables that accepts a variance corrosion that clarify the magnitude of the variance of forecast error that is identify over time by the shocks to each of the causal variables. Consequences of this study shows that there is indication of large heterogeneity among the impacts of variables and the countries.

Guo (2013), investigate the interesting relation among the Kuznets curve of income and carbon. Current study focuses on the interaction effects of distribution of income and income per capita on the emanations of carbon (CO_2) by utilizing the panel data of country group from the period 1980 to 2006. This study using the estimated methods of random effects (RE), fixed effects (FE) and feasible generalized least squares (FGLS). The outcomes are firstly, the disparity of an income of a cross-country has an indirect consequence on the average level of emanations of carbon dioxide (CO2) but a direct consequence on the aggregate elasticity of income of the releases of carbon dioxide (CO2). Secondly, there is a presence of an inverted-U relation among the emissions of per capita carbon dioxide (CO2) and income per capita in all sample of countries and the groups of higher-income. Thirdly, the negative or indirect consequence of income discrepancy on the average level of the releases of carbon dioxide (CO2) diminish alongside with the per capita growth of income. Therefore, growth of an economy contributes to the lessening of this negative or indirect influence.

Hassan et al. (2015), examine the key driving forces that affect short run and long run emissions of carbon pattern caused by the fluctuations in growth, poverty and inequality triangle in the case study of Pakistan for the year 1980 – 2011. Current research using approach of multivariate co-integration. This article used five different models and their results demonstrate that in the short run, there is a direct relation among, i) income inequality and the growth of economy; and ii) income inequality and poverty. There is an indirect relation among carbon releases & the growth of an economy and poverty & growth of an economy. In the long-term, there is a direct relation amongst the inequality of income and GDP (Gross Domestic Product), income inequality and emissions of carbon, and inequality of income and extreme poverty in Pakistan. On the other hand, there is an indirect relation among the growth of an economy and emissions of carbon, inequality of income and carbon emanations, and disparity of income and the growth of an economy. The outcomes of the hypothesis Environmental Kuznets Curve (EKC) investigate an inverted U-shaped curve in relative to growth of an economy in Pakistan.

Ohlan (2015), investigate the effect of size of population, energy growth, usage of energy, and openness of trade on the emanations of carbon in India by using the yearly data over the year 1970-2013. This research applies the approach of Autoregressive Distributed Lag (ARDL) bounds testing to co-integration for founding the presence of a long-term relation and to conclude the direction of causality amongst the variables, this research utilize the Vector Error Correction Model (VECM). The results shows that the consumption of energy, population density and growth of an economy have a direct consequence on the releases of carbon in the short and long period. Population density demonstrates the main factor of manipulating factor of emissions of carbon changes and a careful policy for the stabilization of population in the country would support in diminishing the emissions of carbon and supporting the economic growth of long-run. Furthermore, the outcome sustenance the actions of sustained policy to grow the alternative sources of energy like renewable, and to usage of clean and green technologies to control emissions of carbon without diminishing the intake of energy.

Uddin et al. (2016), shows the relationship of long-run Granger causality amongst the usage of energy, growth of an economy, carbon emissions and openness of trade in the case study of Sri

Lanka. Examination of this research reveals that, there is an occurrence of a long-term causal relation amongst the growth of an economy and the releases of carbon for the country Sri Lanka for the year of 1971–2006. Furthermore, there is unidirectional causality running from the growth of an economy to the usage of energy and the emissions of carbon. The result of this study shows that reduction in carbon emission policies will hurt the growth of an economy if there is no supplementary strategies that are taking to adapt this causal relation.

Sikdar et al. (2016), investigate the current study that improves an econometric model to clarify the causal relation among the emissions of carbon and population, given the industrial structure, structure of population and the growth of economy in the case study of India. Based on the exercise of this modelling, the paper estimates the usage of energy and generation of the releases of carbon dioxide (CO2) in the year 2050. The current study plans that in 2050, the total emissions of carbon dioxide (CO2) in India will be 3.5 million metric tons.

Zhang et al. (2017), evaluate the unequal impacts of consumption of household through different income households overall carbon emissions, by employing a method of hypothetical extraction and the model of semi-closed input-output. The outcomes of current study show that, firstly, the impact on the releases of carbon created by the consumption of the households of urban areas are 1.8 times approximately that of consumption of rural household. Secondly, from the economy by excluding the consumption of the households of higher-income would cause superior reductions in carbon emission than lower-income households. Urban highest income households and families living with the wealthiest in remote areas are 3.8 and 1.8 times respectively on the comparative declines of the households of minimum income. Thirdly, from the food sectors the relative declines of families the emanation of carbon is the greatest, whereas least from the residential sectors. Based on the arguments of this research, this paper places onward the implications of consumption-based policy.

Islam et al. (2017), analyzes the relation between the degradation of environment (carbon emission), total consumption of energy, growth of an economy and the expansion of industrial production index in the case study in Bangladesh from period 1998 to 2013. Current paper usages (VAR) Vector Auto regression Model and variance decomposition of VAR (Vector Auto regression) to evaluate the outcome of such variables on the emissions of carbon. The outcomes of VAR model suggest that GDP per capita and industrial production has direct connection with the emission of carbon. Moreover, investigation through variance decomposition indicate over time, emissions of carbon has reliable influence on industrial production, while industrial production has greater effect on carbon emanation in the short period that disappears in the long term which is reliable with the hypothesis of Environmental Kuznets Curve (EKC). Emissions of carbon increasing alongside with GDP per capita and all together having little effect in the long period on industrial index that specifies over time, there might be further sources of pollution that presented with the increase in income of the economy.

Grunewald et al. (2017), analyzes the theoretically unclear relation among income inequality and emissions of per capita carbon dioxide (CO_2). Perhaps, superior group-fixed effects estimator was selecting by authors also concluded that for low-income economies and the economies of middle-income, higher inequality of income linked with the lesser emissions of carbon whereas in economies in the upper middle class and the economies of greater income, per capita emissions of carbon are increases by the higher inequality of income.

Khan & Siddiqui (2017), goals to achieve household survey-based estimation of the emissions of greenhouse gas in CO2 corresponding carbon emissions (CO2e) from cities inhabited consumption of electricity, transportation (combustion of automobile) and usage of cooking or heating the fuel in Lahore, Pakistan in a year 2016. Overall households are 300, 100 from Awan Town, 100 from Walled City and 100 from the area of Model Town were surveying using a questionnaire of semi-structure. Total estimations were 0.78 Gg CO2e per month, from which the consumption of fuel for domestic automobiles that contribute 0.53 Gg CO2e (69 %), consumption of electricity contribute 0.15 Gg CO2e (19 %) and intake of cooking or heating the fuel for automobiles contribute 0.098 Gg CO2e (12 %) per month. The outcomes shows that the socio-economic features are key significant cause for the emissions of greenhouse gas (GHG).

Knight et al. (2017), examine the relation among the inequality of domestic wealth and the emissions of consumption-based carbon for 26 countries of high-income from period 2000-2010. The result of the two-way fixed effects longitudinal models shows that the outcome of disparity of wealth that measured, as the share of wealth of the top decile, in high-income countries on per capita emissions, is direct and stable over the time. These results are consistent with theories of political economy claiming that the concentration of political power and the power of an economy that go with the attention of wealth that perform an imperative role in preventing the actions of pro-environment and increasing the degradation of environment.

Ota (2017), inspecting into the form of Environmental Kuznets Curve (EKC) for sample of 20 member countries of Asian ADB to evaluate the influence of growth of an economy on degrading the environment. This study shows that both Asian trends in the disparity of income and in the degrading the environment appear, generally, to follow Kuznets' hypothesized curve up to the lesser level of great income as income increases, although divergent trend could be detected between economies that are in range of great income. There are Irregularities in the curves that shows changing relationships (i-e, the relation among income and the emissions of carbon, and the connection among income and the inequality of income) that seem to develop increasingly difficult. As income rises for countries within the range of high-income, however the irregularities seem to be recurrent in the pattern of Environmental Kuznets Curve (EKC).

Jorgenson et al. (2017), analyze the relation among U.S. state-level emanations of carbon dioxide (CO_2) and there are two measures for inequality of income: the income and Gini coefficient share of the top ten percent. Time-series cross-sectional Prais Winsten regression model was used by authors in this study and concluded that state-level emanations are directly related with the share of income for the top ten percent, whereas on emanations the outcome of the Gini coefficient are non-significant.

Rao & Min (n.d.), examine that is there a battle between diminishing global inequality of income and battling climate change? This study built mostly on the observation that a dollar that spent at greater levels of income is less concentration of carbon than at lower levels of income. This study quantify the most extreme appearance of this consequence at a global scale based on unprecedented rates of change in the inequality of income within and among countries by 2050. This study indicate that at worst emissions of global may increase by a few percent but diminish if the income convergence between countries controls future trends in the inequality of income globally. It shows a disruption for future study to dwell on this concern that when there are deeper under-explored connections and interactions among mitigating climate change and reducing income inequalities, such as the consequence of diminishing disparity on consumption, social norms, and mobilization of politics round the policy of environment.

Aye & Edoja (2017), investigate the consequence of the growth of an economy on the emissions of carbon. This study using the framework dynamic panel threshold. The study based on panel data from 31 emerging countries. The estimations shows that the growth of an economy has positive and direct consequence on the emissions of carbon in the growth of high regime but negative or indirect consequence in the growth of low regime with the marginal outcome is being greater in the regime of high growth and a U-shaped relationship is established. Population and the consumption of energy had positive or direct effect on the emissions of carbon. The findings of this study highlight the essential for transformation of technologies of low emissions of carbon aimed at sustainable growth of an economy and diminishing the emissions.

Baloch et al. (2018), inspect the consequence of the growth of an economy and income inequality on the degradation of environment in Pakistan by using the approach of ARDL bounds testing for the period of 1966–2011. The estimated outcome of this study shows that emissions of carbon increase as the increase in the gap of income in Pakistan. Further the indirect influence of population density and industrial share on the emissions of carbon dioxide (CO2), the current study confirm that the growth of an economy in Pakistan comes up with greater emanations of carbon and the hypothesis of Environmental Kuznets Curve (EKC) is not effective for Pakistan throughout the research period. Current study recommends that the circulation of income matters to the aggregate emanations of carbon and focus should made on continuous growth of an economy to diminish the pollutants and therefore the emissions of carbon dioxide (CO2) in the study area.

Ameyaw & Yao (2018), inspect the relation amongst gross domestic product and the emanations of carbon in five nations of West Africa. The statistic collected from year 2007 to 2014 by utilizing method of panel data. Causality tests indicated that the association involving GDP and the emanation of carbon is unidirectional. Anticipate emanations of carbon for Africa with the goal of projecting future level of usage after identifying the relation amongst gross domestic product GDP and the emanations of carbon. Reliable and slightly elevated total emanations of carbon prediction are critical for emerging and executing feasible ecologically friendly climate security in the drive to meet the goals of climate change emanations diminishes. A strategy for predicting long-term total carbon emanations that not based on expectations. On Africa's statistic acquired including the selected five West African nations used hereby, executing bidirectional long short-term memory sequentially algorithm formation for both the experimental phase (2006–2014) and the predicting phase (2015–2020). Authorities in Western Africa and Africa itself should set reasonable and lengthy policy goals.

McGee & Greiner (2018), examine that in many developed nations, the growth rate of carbon emissions has diminished, cumulating to the latest time of decoupling among the emissions of carbon and the growth of an economy. The motive of this current article is to improvement in the research on socioeconomic drivers of the emanations of carbon by evaluating in what way the distribution of income disturbs the relation among carbon emissions and the growth of an economy. This study find that from period 1985 to 2011, increasing in the inequality of income leads to a tighter coupling among carbon emissions and the growth of an economy in developed nations. Furthermore, in the top 20 percent the increase of the share of income earners of the national income that caused in a greater link among the emissions of carbon and the economic growth. While in the bottom, 20 percent the increase in the share of income earners of national income diminished the link between the emissions of carbon and the economic growth.

Mondal & Mondal (2019), inspect the influence of Bangladesh's population growth and change in climate on the country's lasting development. Current study based on a review of historical statistic and a compilation of literature on population expansion, greenhouse gas emanations, climate variability, security of food, and long-term prosperity, with a focus on Bangladesh. Bangladesh's population nearly doubled amid years 1980 and 2015, according with research. In 2013, the country had 2.2 percent of the worldwide population but only 0.19 percent of worldwide carbon dioxide emanations. Changing in the climate, on the other perspective, is the country's greatest challenge. Temperature upsurges could diminish rice and wheat yields. Consequently, warming trend would consequence in an upsurge in average rainy season. Temperature and rainfall upsurges may induce the rainy season to arrive earlier and leave later or elevate the mean everyday rainfall severity. The effects of the expansion of population and the change in climate on development are numerous. As consequence, if the change in climate continues to threaten Bangladesh's economic progress, environmental constancy, and social advancement, supportable development may be difficult to accomplish.

Demir et al. (2019), inspect the influence of income disparity on environmental condition in Turkey by utilizing the concept of Environmental Kuznets Curve. For the year from 1963 to 2011, an autoregressive distributed lag bounds test on the emanations of carbon was utilized to detect the long- and short-term consequences of wealth disparity on environmental condition. The outcomes demonstrate that there is a poor association amongst pollutant emanations and income disparity in Turkey, implying that up surging income disparity diminishes environmental deterioration. Consequently, more societal disparity leads to diminish aggregate usage in the economy because of wealthier families' lower tendency to pollute, resulting in enhanced environmental stewardship. The conclusions corroborate an interpretation in the literature that implies that, until a certain degree of prosperity is reach, ecological destruction improves as income disparity in society diminishes in emerging countries. The conclusions also back up the Environmental Kuznets Curve theory.

Ardakani & Seyedaliakbar (2019), examine the relationship of the consumption of energy, emanations of carbon (CO2) and energy growth in the context of the Environmental Kuznets Curve (EKC). This study emphases on seven oil-rich countries in the North Africa (MENA) and Middle East region, namely, Algeria, Bahrain, Kuwait, Iran, Qatar, Saudi Arabia and Oman, for the year of 1995–2014. The intention of this research is to inspect how emissions of carbon dioxide (CO2) is affecting by GDP, consumption of energy and GDP2. In addition, can examined in a format of panel data or a format of multivariate regression. This study provides a systematic guidance in a format of multivariate regression and check its assumptions that properly analyze the problem.

Ribeiro et al. (2019), investigate the effects of changing the size of population on the emanations of carbon in urban areas. Results of this study improve description of emanations and disclose the role of coupled among density and population on emanations and that variation in emanations related with equivalent changes in size of population that may depend on the magnitude of these changes and also depend on the early values of these quantities. For the areas of US, the larger the volume of city, the greater is the influence of changing its density of population on its emanations; nevertheless, changes in population always have a bigger influence on the releases of carbon than the effect on the size of population.

Vo et al. (2019), examines the causal connection among the emanations of carbon renewable energy, the consumption of energy. The growth of an economy and the population for countries in the region. By utilizing numerous approaches of time-series econometrics, the investigation of this study covers five members of ASEAN (including Malaysia, Indonesia, the Philippines, Myanmar, and Thailand) for the year of 1971–2014. The results of current paper illustrate that there is no long-term relation amongst the variables of attention in Thailand and the Philippines, but there exist a relation in Indonesia, Malaysia and Myanmar. The Environmental Kuznets Curve (EKC) hypothesis is observed in Myanmar but not exist in Malaysia and Indonesia. Indonesia practices a unidirectional causal outcome from the expansion of an economy to the renewable usage of energy in both long run and short run, and from the growth of an economy to the consumption of energy and carbon emanations. Only Myanmar has a unidirectional outcome from energy consumption, the growth of GDP (Gross Domestic Product) and the population to the acceptance of renewable energy. Implications of Policy have developed based on the results attained from current research in the region of ASEAN region for each country.

Uzar & Eyuboglu (2019), inspect the consequence of distribution of income on the emissions of carbon in Turkey for the period 1984-2014. The test results of an Autoregressive Distributed Lag (ARDL) indicate that the series are co-integrating and that on carbon emissions; inequality of income has a positive or direct effect. Results also shows that in Turkey, the environmental Kuznets curve (EKC) is appropriate. The test of the Toda-Yamamoto causality indicates that the Gini coefficient is the Granger-cause of the emissions of carbon and results indicate that in Turkey, corrosion in the distribution of income will diminish the quality of an atmosphere, which authenticates that in Turkey approach of political economy is effective.

Khoshnevis & Dariani (2019), inspects the dynamic causal relation among the emissions of carbon dioxide (CO2), growth of energy, consumption of energy, urbanization and trade openness over the year 1980–2014 by utilizing the panel Granger causality tests and for the countries of Asia the pooled mean group (P.M.G.) approach Granger causality. The outcome of this study shows that the urbanization upsurges the emissions of carbon and energy consumption. The consequences of Granger causality test validate that there is a relation of bidirectional causal among urbanization, carbon emissions and the growth of an economy. In the eastern region, consumption is upper than the effect on the emissions of carbon and some indication supports the theory of dense city. The results of this study pay not only to progressing the present literature, but also justify special consideration in countries of Asia from policymakers and urban planners.

Chen et al. (2020), examine whether and how distribution of income that affects the emissions carbon during the growth of economy economic below the framework of extended Environmental Kuznets Curve (EKC). By using the analysis of simultaneous quantile regression, and shows that, for developing countries, an equal distribution of income favors in reductions to the per capita carbon emissions, while inequality of income hardly affects the emissions of carbon in most developed countries. Meanwhile, the hypothesis of Environmental Kuznets Curve (EKC) is effective in G20. Built on the empirical outcomes, this study mainly highlight the importance of reduction in the inequality of income in emerging countries and that the whole G20 takes the path of maintainable growth.

Perwithosuci et al. (2020), looked at the impact of GDP, usage of oil, population and FDI on the emanations of carbon in the five emerging nations of ASEAN of Thailand, Malaysia, the Philippines, Indonesia and Vietnam. The World Bank and British Petroleum statistics utilized to create this report from year 1985 to 2017. Because there were more time series than cross-sections in this research, the procedure of Fixed-Effects utilized to evaluate panel data. The test of Hausman, on the other contrary, demonstrated that Fixed-Effects is substantially favorable. The consequences of the Fixed-Effect assessment exposed that the usage of oil, gross domestic product and population all have a direct influence on the emanations of carbon at a level of 5 percent. Nevertheless, at a level of 10 percent, FDI has an indirect influence on the emanations of carbon. The concept of Halo Effect concept corroborated by the indirect relation amongst emanations of carbon and foreign direct investment. To diminish the emanations of carbon, minimal carbon innovations should utilize as a policy suggestion.

Muhammad et al. (2020), inspect the impacts of usage of energy and size of population on the emanations of carbon in Pakistan. , the consequence of the trade and growth is also determined in this study by utilizing the method of Fully Modified Least Square (FMOLS) from the period of 1990 to 2014. Furthermore, vigorous analysis is taken by applying method of Dynamic Ordinary Least Square (DOLS). Firstly, test of unit root is test by Augmented Dicky Fuller (ADF) test and Phillips-Perron (PP) test, and Johansen Co-integration test is applying for the relationship of long period. The consequences of this article show the powerful contribution of energy consumption and population density on environmental decay in Pakistan. The result of current study also shows that in Pakistan, energy consumption and population density are contributing carbon emissions. Consequently, this study endorses that the control of population should be the goal of the government officials, limit, and announce the friendly environment sources of energy.

Uddin et al. (2020), investigate whether the inequality of income caused the emissions of carbon in what are now the richest countries of world over the year of 1870 to 2014. By applying a method of non-parametric panel valuation with cross-sectional and time-varying coefficients, this study find out the bond among carbon emissions and inequality of income is non-linear. In terms of significance and signs, for income inequality the non-parametric coefficient function is discovered to differ from the period of 1870-2014. Income inequality shows a direct impact from the period of 1870 to 1880 and a significant negative or indirect effect from the period of 1950 to 2000 on carbon emissions. This study also discover that for prolonged period among1881 and 1949 and among 2000 and 2014, so between the two variables, there is no significant relationship

Ghafoor et al. (2020), inspect the consequence of emanations of carbon and the consumption of energy of residential buildings in Lahore. This study based on a questionnaire survey that was conducting in Lahore on a sample for 300 buildings for inhabitants and their emanations of carbon from natural gas and the consumption of electricity were calculating by using IPCC methodology. The consequences indicate that natural gas and electricity consumption released 7.65 MMt carbon emissions during the research time of one year. It was examining that class of an income ($p<0.001$), area of house ($p<0.001$), the size (tons) of AC ($p<0.001$), building type ($p<0.001$), kitchens in number ($p<0.01$) and season ($p<0.001$) had a direct connection with the emanations of carbon and the consumption of energy. On the other side, roof insulation ($p<0.01$) had an indirect relation with carbon emission and the consumption of energy. This study suggest that to enhance thermal characteristics of prevailing buildings and for new housing construction implementation of building energy codes and increase the awareness amongst inhabitants for the acceptance of energy conservation measures to decrease the emissions of carbon.

Kusumawardani & Dewi (2020), examine the consequence of inequality of income on the emanations of carbon in Indonesia from year 1975 to 2017. Per capita GDP, dependency ratio and urbanization are using as further variables in the analytical models. Autoregressive Distributed Lag (ARDL) technique was using by authors and concluded that income disparity has an indirect consequence on the emanations of carbon dioxide (CO_2), but the pattern of relationship depends on the level of per capita GDP (Gross Domestic Product). An inverted U-shaped relation shows that the presence of an Environmental Kuznets Curve (EKC), both urban population and the ratio of dependency on the emissions of carbon dioxide (CO_2) have a negative or indirect effect. To certify that there is a lessening in the emissions of carbon dioxide (CO_2), this study recommends that inequality of income should added to the policies formulated to aid to the growth of an economy in country.

Baloch et al. (2020), analyze the association among income inequality, emissions of carbon and poverty for the 40 Sub-Saharan African countries from year 2010 to 2016. Outcomes attained from the estimator of Driscoll Kray regression, which recommend that an upsurge in income disparity add to the emanations of carbon dioxide (CO_2). Furthermore, an upsurge in poverty has a harmful consequence on the pollution of environment in Sub-Saharan African countries. The outcomes recommended that an essential consequences for policy in view of Sustainable Development Goals (SDGs) for the paper of selection of countries.

Rahman et al. (2020), inspect the impact of population density, carbon dioxide (CO_2) emissions, and openness of trade on the growth in the economy of five South Asian countries. Using statistics from year 1990 to 2017, the panel co-integration approach of a prolonged neoclassical growth model employed. The outcomes expose that population density and carbon dioxide (CO_2) emanations have a direct influence on the growth of an economy in South Asian countries, whereas trade openness has a detrimental or indirect impact. Granger Causality results reveal bidirectional causality both carbon dioxide (CO_2) releases and growth of an economy, including between carbon dioxide (CO_2) emissions and trade openness. Yet, there is unidirectional correlation among openness of trade and the growth of an economy, as well as between concentration of people and economic expansion.

Mushtaq et al. (2020), evaluate the influence of financial progress and the growth of an economy on carbon dioxide (CO_2) emanations in China, both at the national and regional levels, using the mitigating function of technology. The authors used a panel data collection of 27 Chinese provinces from 1995 to 2015. In the current study, the authors divide the sample into six sections. Panel-Corrected Standard Errors(PSCE), Fixed Effect(FE), Nadaraya-Watson(N-W), and Feasible generalized Least Squares(FGLS) regression models were used to find that as the wealth gap widens, carbon emissions rise. Innovation not only has a direct influence on carbon dioxide (CO2) emanations, but it also moderates the relation amongst carbon emissions and economic inequality both at the national and regional levels. The relation amongst the progress of an economy and carbon emissions is nonlinear. This observation proves the presence of an Environmental Kuznets Curve in China (EKC).

Liu et al. (2020), inspect the consequence of income disparity on the releases of carbon of household in China using micro panel statistics nationwide. Consumption patterns, time preference, and mental health are additional variables. Panel regression model was using by authors and concluded that income disparity has a direct influence on the carbon emanations of household in China. Patterns of consumption, time preference for consumption, and mental health can affect the direct impacts of disparity of income on household levels of carbon emanations and substantial differences are establishing among households at income of different level and households with heads of different ages.

Odhiambo & Nicholas (2020), use a sample of 39 Sub-Saharan African nations, including countries with a low and moderate income, to evaluate how rising disparity disturbs renewable source of energy usage. The empirical data based on Tobit quadratic regressions. Because of the fundamental consequences in the form of the threshold, the equality hypothesis is appropriate when the Atkinson index is lower a threshold of 0.6180, and the disparity hypothesis is appropriate when the Atkinson index surpasses the barrier of 0.6180.

Hailemariam et al. (2020), investigate whether changes in disparity of income affect the emissions of carbon (CO_2) in OECD countries. Authors used panel data for estimation techniques and concluded that a rise in the Gini index of disparity connected with a lessening in the emanations of carbon, consistent with the marginal propensity to emit approach as findings reveal a non-linear relation amongst growth of an economy and the emanations of carbon dioxide, consistent with Environmental Kuznets Curve (EKC).

Yang et al. (2020), investigate the influence of financial instability on the relation amongst income disparity and emanations of carbon (CO2). For the period 1980–2016, the authors used panel data from 47 developing or emerging nations. The stochastic effects by regression on population, affluence, and technology (STIRPAT) model are being use in the current investigation. The results of all of the models show that industrialization and income disparity minimize environmental degradation, whereas fossil fuels, economic expansion, and trade openness reduce environmental quality. An upsurge in income disparity, ceteris paribus, along with an increase in financial instability, is expected to result in an upsurge in pollution. Furthermore, a bidirectional causal link exists between income disparity, fossil fuels, financial instability, industrialization, openness of trade, growth of an economy, and the contact variable with carbon dioxide emanation (CO2).

Ullah & Awan (2020), inspect the association between the growth of an economy and the quality of environment along with role of inequality of income within the framework of Environmental Kuznets Curve (EKC). Using three variables of the quality of environment (CO2, SO2 emanation and PM2.5 concentration). The study based on panel data of developing or emerging countries of Asia. By applying PMG estimation technique, results confirmed that in the long run the existence of Environmental Kuznets Curve (EKC) for all indicators of environmental condition for emerging Asian economies. Findings shows that income disparity is directly related to SO2, emissions of carbon dioxide (CO2) and PM2.5 concentrations. Furthermore, urban population, population density, openness of trade and foreign direct investment are also directly relating with all the variables of environmental quality.

Kebede Hundie (n.d.), inspect the linkage among income disparity and the emissions of carbon in Ethiopia for time length covering years from 1979 to 2014. Author used the approach of ARDL bounds test and DOLS to co-integration and concluded that a 1% upsurge in income disparity that upsurges the emissions of carbon dioxide (CO_2) by 0.21% in the long run during the period of research. In the long run a 1% increase in urbanization, size of population, energy intensity and industrialization each directly add to the degrading the environment in Ethiopia by 0.38%, 0.22%, 0.07% and 0.11% respectively. Except for economic growth, the results reveal a bidirectional causal relation amongst emanations of carbon and all other variables.

Duarte et al. (2021), reflects a concern of how to diminish the emanations of carbon and the pathway towards the enhancement of environment. This study explore the nexus between the consumption of household patterns in income disparity, EU and global carbon emanations trends, by applying an environmentally extended multiregional and multi-sectoral input-output model. This research trends in global emanations of carbon linked with the different consumptions of household patterns and income categories over the period of 15 years, and estimate the role of consumption patterns, distribution of income and technological conditions by income group and country. Furthermore, through certain set-ups, the prospective attainment of double dividends, by reducing emissions and alleviating poverty.

Zarco-Periñán et al. (2021), inspect the influence of population size on electricity usage and emissions emitted in buildings in this research. Further, the influence of the climate was abolished in order to demonstrate its influence quite vividly. Electrical and thermal energy are the most common forms of energy usage in buildings. The research done on a per-inhabitant and per-household basis at the city scale. The city's real footprint taken into account. The proposed strategy was test on Spanish metropolitan areas of more than 50,000 people. The research revealed that as density of population climbs, so does energy usage per person and household in structures. Thermal energy usage is elastic, whereas the usage of electricity is inelastic, changing by more than 100 percent across extremist groupings. When it comes to carbon emanations, the denser the population, the stronger the emanations. Electrical emanations fluctuate by less than 2 percentage points and are higher than those from thermal sources are. Additionally, when density of population grows, the proportion of emanations from electrical sources lessens from 74 percent to 55 percent of total pollutants. This research aims to assist officials and utilities in taking the necessary steps to promote the usage of energy that is renewable and prevent Pollution.

Osadume & University (2021), inspect the effect of the growth of an economy on the emanations of carbon on selected countries of West Africa between period 1980 and 2019. The required theoretical underpinning is provided by the model of Simon-Steinmann economic growth. The major goal of this research was to see if economic expansion has an impact on carbon emissions using secondary data acquired from the World Bank Group's online database and statistical analysis using panel econometric methods. In the short run, the independent variable had a direct influence on the dependent variable, with significant co-integration, as shown by the results. According to the current research, growth of an economy has a considerable influence on carbon emanations, with a 1% rise in the growth of an economy resulting in a 3.11121 percent unit increase in the emanations of carbon. In terms of practical ramifications, policy implementation should boost the use of energy-efficient facilities by government and businesses, as well as the establishment of carbon trading centers. According to the social implications, governments' failure to heed the current research's recommendations will result in major climate change affecting economic activity, as well as associated costs to human health in the region and beyond.

Li & Xiao (2021), investigate the relationship among the inequality of income and subjective environmental pollution (SEP). From the Chinese General Society Survey (CGSS) in 2013, using the micro statistics and at the provincial level, official statistical data used, this study examine the influence of income disparity of individual-level on subjective environmental pollution in China. The outcome of this study shows that with subjective environmental pollution, individual-level of disparity of income has inverted U-shape relationship, which express that rising the income disparity at the level of individual will first upsurge and then diminish their apparent subjective contamination of the environment after getting the top. About 84% of respondents, their subjective contamination of the environment declines with the surge of income inequality of individual-level. The evaluates of heterogeneity indicate that the income disparity of cities inhabitants and of the local inhabitants have an inverted U-shape influence on SEP, and the SEP of females and of entities with positive environmental approach are more complex to the outcome of income disparity. This study discover out that subjective well-being plays a facilitating role in the relation amongst SEP and income disparity. This study also find that exposures of non-television media, such as newspaper, magazine, broadcasting etc. will strengthen the consequence of the income inequality of individual-level on subjective environmental pollution (SEP).

Caporale et al. (2021), examines the connection among the logarithms of real Gross Domestic Product (GDP) and the emissions of carbon dioxide (CO2) in China by using the fractional integration and co-integration methods. . The univariate results shows that the two series are highly persistent, their integration orders are being around 2, whereas the co-integration tests (using both techniques of standard and fractional) suggest that there occurs a relationship of long-run equilibrium among the two variables in first differences, i.e., in the long run, their rates of growth are linked together. This suggests that during periods of the growth of an economy, there is a need for environmental policies that targeted at decreasing the carbon emanations.

Wang et al. (2021), examine the linkage amongst income disparity, renewable energy, and the emanations of carbon from 1990 to 2018. A model of an autoregressive distribution lag was used to evaluate the short- and long-term interaction (ARDL). Enhancements in sustainable electricity, as well as wealth inequality, are creating an increase in the condition of the environment, according to the discoveries of the current research. Natural resources appear to have a direct influence on environmental quality. Furthermore, this research discovered a bidirectional causal link amongst environmental quality and financial progress. According to the outcomes of the current research, government officials should encourage the use of renewable energy, i.e., sources that reduce carbon emissions.

Hasan et al. (2021), examine the connection among the growth of an economy and the quality of an environment by incorporating inequality of income. Current study using panel data from period 1991 to 2016 of five countries of SAARC. By employing, the model of fixed effect and found that Environmental Kuznets Curve (EKC) verified for entire panel and the inequality of income has positively or direct effects on the quality of environment. The correlation between carbon emissions and FDI is positive but a small effect. The correlation between education and carbon emission is negative. The influence of size of the population on the emanations of carbon is positively and significantly. The results of this study indicate that in Pakistan; mean carbon emission is 0.01, which is fear for Pakistan. In India, the mean carbon emanation is 0.53, which shows that mean emanation for carbon in India is increasing. Mean emanation of carbon is -0.10,

-0.04 and -0.21 for Sri Lanka, Nepal and Bangladesh respectively, which suggests that mean emanation of carbon in such countries is diminishing.

Lateef et al. (2021), investigate the determinants of an economy of carbon emanations (CE) and dynamic causal communication of carbon emissions (CE) with economic growth (EG), foreign direct investment (FDI). Other factors of an economy by using the approaches of dynamic ordinary least squares (DOLS), panel co-integration test and vector error correction model (VECM) for the countries of SAARC for the period from 1990 to 2016. The outcome of current study confirmed that the existence of the unidirectional causal connotation of the emissions of carbon with the growth of an economy. The panel outcomes of other factors of an economy reported that the causality of energy consumption (EC) and urban population (UP) with carbon emanations (CE). Domestic capital (DS) and rate of inflation (INF) panel results established the causal relationship with EG. Finally, the DS panel data exposed a link between FDI and DS.

Alabi et al. (2021), looked at the causes of pollution of environment and degrading the environment in Sri Lanka. Yearly data used from 1971-2014. An autoregressive distributed lag (ARDL) model used in current study. Outcomes of this research shows that the hypothesis of both Environmental Kuznets Curve EKC and pollution haven are appropriate to Sri Lanka. Long-term estimations indicate that growing consumption of energy leads to rise in the emissions of carbon. This study also observed that the consumption of energy, trade openness, urbanization, financial development and tourism are amid the crucial factors that are concerned for the atmosphere's condition in a country. In order to save the environment, Sri Lankan Government should implement the saving of energy and friendly environment technologies and the process of production.

Wang & Zhang (2021), applying the influence of narrowing the gap of urban-rural income on the control of pollution and the reduction in the emissions of carbon by using the technique of Ordinary Least Square (OLS). The outcomes of this study suggest that closing the urban-rural income gap has a direct influence on the control of pollution, albeit there are regional disparities in the effect on lessening the emissions of carbon. The closing of the gap amongst urban-rural income, in the eyes of the entire country, as well as the central and western areas, is encouraging to the reduction of carbon emissions. However, in the eastern region, where the level of economic development is particularly high, and the decreasing income gap between urban and rural boosts carbon emissions.

Khan & Yahong, (2021), applying the co-integration approach of an Autoregressive Distributive Lag (ARDL) along with Nonlinear Autoregressive Distributive Lag (NARDL) in the framework of Pakistan for the year 1971–2015, investigate the short and long run influence of poverty, population, income disparity, and GDP per capita on carbon dioxide (CO2) emissions. The symmetric results of this study reveal that the size of population, poverty, and GDP per capita all raise emanations of carbon in the long and short run, whereas income disparity has no effect on the emissions of carbon in the short run. In the long run, however, the symmetric consequences illustrate that wealth disparity reduces degrading the environment in terms of emissions of carbon. The NARDL (Non-linear Autoregressive Distributive Lag) study backs up the ARDL findings, indicating that poverty, growth of an economy, and population have a direct influence on the emanations of carbon in Pakistan. The current study's empirical outcomes have policy implications for Pakistan's development in light of the United Nations' Sustainable Development Goals.

Adeleye et al. (2021), investigate the role of per capita income on the emanations of carbon in moderating the influence of the use of energy. By utilizing the data from selected 28 countries of Africa for the period of 1990 to 2019. This study uses techniques of FGLS, PCSE, and MM-QR and results shows that across the sub-regions, significant heterogeneities occur. Southern Africa is the largest provider of energy to emanations (1.65%), whereas Central Africa is the largest contributor of emissions (1.87%) due to rising per capita income. With a control effect of -0.56 percent, West Africa has the biggest control effect. Per capita and energy, use had beneficial benefits throughout the quartiles. The tight link between per capita income (i.e., economic growth) and energy consumption presents a problem for African economies in their quest for growth. According to the findings, countries of Africa seek more progress without contributing to emanations of carbon, and administrations should spend extra in renewable sources of energy. The lesson of this research is that without contributing to carbon emissions, countries of an Africa seek for more development; governments must invest more in renewable energy.

Cui et al. (2021), examine how does the efficiency of carbon emission reduction affect regional income disparity? Using data from China from 2007 to 2017, this study employed the mediating effect model and the DEA approach. The findings of this article show that when efficiency of carbon emission reduction rises by one unit, the income disparity gap for 25 provinces rises by 0.0202 units, provinces with medium efficiency of carbon emission reduction that rise by 0.026 units, and provinces with high efficiency of carbon emanation reduction that rise by 0.107 units. Nevertheless, the income disparity gap among provinces with low efficiency of carbon emission reduction diminishes by 0.0390 units. According to above findings, the active measures to narrow the disparity of income are to implement policy of lessening in the emissions of carbon, industrial policy, public service policy and the policy of education investment.

Yang et al. (2021), investigate the regional, provincial, and national disparities in carbon emissions per capita (CPC) in China, as well as the factors that influence them. In China, the CPC disparity index improved from 1.1364 in 2000 to 2.3688 in 2017, with the productive sector accounting for

91.42 percent of the increase and households accounting for the rest. 69.01 percent, 5.57 percent, 12.81 percent, and 4.03 percent of these discrepancies are explained by the production-side per capita level of output, energy structure, energy efficiency, and industrial structure, respectively. Furthermore, only 0.46 percent and 8.12 percent of the variance is explained by the household per capita energy structure and energy use, respectively. As a result, future responsibility-sharing arrangements to help with climate change mitigation must primarily target the productive sector.

Tanchangya & Zhou Ayoungman (2022), examine that Bangladesh's carbon emissions are influence by poverty and population expansion. In Bangladesh, a current study is being undertake on the short- and long-term effects of poverty, population, economic disparity, and GDP per capita on carbon emissions. In Bangladesh, this consequence was inspected by using the co-integration methods of an Autoregressive Distributed Lag (ARDL) and a Non-linear Autoregressive Distributed Lag (NARDL) with yearly data from 1983 to 2020. Short-term carbon emissions are increase by poverty, GDP per capita, and population density, however long-term emissions are less affect by the economic gap. Economic differences reduce carbon emissions, according to asymmetric results. The Non-linear Autoregressive Distributive Lag (NARDL) findings recommend that economic growth of Bangladesh have positively or direct impacts carbon emissions.

Uzair Ali et al. (2022), inspect the influence of development of the economy, usage of fossil fuels and the size of population on the emanations of carbon in Bangladesh, Pakistan and India. Using yearly statistic over the year from 1971 to 2014. To evaluate the long-term behaviors, a panel Autoregressive distributed lags model was in use, as well as procedure of Vector error correction. The Granger causality examination is performed to evaluate the direction of causality. The detailed consequence has recognized key relation that have key reform consequences utilizing model with three multivariate equations. To begin, the consequences of auto-regressive distributed lags (ARDL) illustrate that the relation amid emanations of carbon and the development of an economy is U-shaped, as predicted by the hypothesis of environmental Kuznets curve. Consequently, in the long haul, usage of fossil fuel and the size of population have a favorable influence on carbon emanations. Consequences recommends that short-term causalities is present from development of an economy to carbon emanations, size of population to carbon emanations and usage of fossil fuel to carbon emanations. Second, CO2 has a detrimental influence on the development of the economy, the long-term effects of fossil fuels, foreign direct investment, and total exports on the development of an economy have been overwhelmingly beneficial. CO2, usage of fossil fuel, and FDI Granger cause economic progress in the near run. Finally, CO2 emissions have a detrimental influence on population size whereas development of an economy has a favorable influence in the long-term. Additionally, short-run causalities connecting development of the economy and population size, as well as carbon emanations and population size, are no longer present. In order to attain policy goals, reliable and low carbon emanations technology should be adopted.

2.1 Summary of Previous Literature

Year	Author's name	Title of Article	Variables	Estimation Technique	Conclusion
2021	Khan & Yahong	Symmetric and Asymmetric Impact of Poverty, Income Inequality, and Population on Carbon Emission in Pakistan: New Evidence from ARDL and NARDL Co-Integration.	poverty, population, income disparity, GDP per capita and carbon emissions	ARDL and NARDL	Population, poverty, and GDP per capita, have positive effect on carbon emissions in the long run whereas income disparity has no effect on carbon emissions in the short run.
2018	Amdadullah et al.	The nexus between income inequality, economic growth and	Carbon emissions, income	ARDL	Positive relationship among carbon emissions and income

		environmental degradation in Pakistan	inequality, GDP, population density		inequality. Positive relationship among economic growth and carbon emissions
2015	Ramphul Ohlan	Impact of population density, energy growth, energy consumption, and trade openness on carbon emissions in India	Carbon emission, population density, trade openness, GDP.	ARDL and VECM	Population density, energy consumption and economic growth have positive effect on CO_2 emissions both in the short-run and long-run.
2019	Umut Uzar and Kemal Eyuboglu	The nexus between income inequality and CO_2 emissions in Turkey	Income inequality, carbon emissions	ARDL	Positive effect among income inequality and carbon emissions
2020	Deni et al.	The effect of income inequality on carbon dioxide emissions: A case study of Indonesia	per capita GDP, urbanization rate, and dependency ratio are considered to be additional variables.	Autoregressive Distributed Lag (ARDL) technique.	income inequality has a negative effect on CO_2 emissions, but the relationship pattern depends on the level of per capita GDP
2021	Shemelis Kebede Hundie	Income Inequality, Economic Growth and Carbon Dioxide Emissions Nexus: Empirical Evidence from Ethiopia	CO_2 emissions, real gross domestic product (GDP), real GDP square, Gini index, urbanization, industrialization, energy intensity and population	ARDL bounds test and DOLS approach to co integration	The long-run empirical results show that a 1% increase in economic growth accounts for a 1.05% increase in CO_2 emissions while a 1% increase in economic growth squared reduces CO_2 emissions by 0.11%. a bidirectional causal relationship between CO_2 emissions and all other variables except economic growth.
2020	Yang et al.	Income Inequality and CO_2 Emissions in Developing Countries: The	CO_2 emissions, income inequality and financial instability	STIRPAT	financial instability shows no significant link to environmental quality, whereas it shows a significant

		Moderating Role of Financial Instability			negative effect on CO_2 emissions. bidirectional causal association among income inequality, financial instability, fossil fuel, trade openness, industrialization, economic growth, and the interaction variable with CO2 emission
2020	Liu et al.	The Impact of Income Inequality on Carbon Emissions in China: A Household-Level Analysis	household carbon emissions is dependent variable. income inequality as a proxy variable	This study relies on a panel regression model	income inequality has a positive impact on household carbon emissions in China. consumption patterns, time preference for consumption, and mental health can affect the positive impacts of income inequality on household carbon emissions.
2020	Mushtaq et al.	Income inequality, innovation and carbon emission: Perspectives on sustainable growth	Income distribution as descriptive variable. Other are GDP, income per capita and energy consumption	FE, PSCE, N-W and FGLS	CO_2 emission increases as the income gap widens. Innovation not only has a direct positive impact on the CO_2 emission but also moderates the relationship of income inequality and carbon emission at the national and the regional level. relationship between economic development and CO_2 emission is nonlinear. There exist an EKC in China
2020	Hailemariam et al.	Carbon Emissions, Income Inequality and Economic Development	Carbon emissions, income inequality and economic growth.	panel co integration analysis.	findings reveal a non-linear relationship between economic growth and CO_2 emissions, consistent with Environmental

					Kuznets Curve. We find that an increase in the Gini index of inequality is associated with a decrease in carbon emissions

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Theoretical Background

Inequality is a concept of multiple dimensions. This study refers the dimension that inequality is the distribution of income. From the mid-1990s onwards, many economists have produced numerous theoretical explanations to describe the link amongst economic disparity and degrading the environment such as Khan & Yohang (2021), Wang et al. (2021), Liu et al. (2020) and many more. Whereas some of the explanations imply a direct link, such as Boyce (1994), Torras and Boyce (1998), and Borghesi (2006)'s "equality hypothesis," others believe that more disparity could be indirectly linked with emanations (Heerink et al. 2001; Ravallion et al. 2000; Scruggs 1998).

The relationship between several measures of environmental deterioration and per capita income is theorized to exist, according to the environmental Kuznets curve (EKC). Pollution emissions rise and environmental quality falls during the early stages of economic expansion, but above a certain level of per capita income, the tendency turns around, and at high income levels, economic growth actually improves the environment. This suggests that the relationship between per capita income and environmental damages or emissions is inverted U-shaped. The EKC is called in honor of Simon Kuznets, who postulated that as economic development advances, income disparity first rises and subsequently declines. The validity of the EKC (Environmental Kuznets Curve) hypothesis is very essential for policy recommendations. If the hypothesis is accepted, this means that economic growth has led to better quality of environment. Therefore, no need to limit growth to protect the environment. However, in contrast, if the hypothesis is rejected then public policies would be necessary to lessen the environmental degradation while in the direction of sustainable development, economic growth is still increasing (Perman et al., 2003).

The theoretical framework encompasses the income inequality, which determine the relation among carbon emissions and the levels of income. According to the EKC hypothesis, environmental pressures increase as income level increases at the initial stage of economic development, but later these pressures diminish along with the income levels (Guo R., 2015). Up surging in the disparity of income are likely to influence the emanations of carbon. Boyce (1994) stated that when the income gap between poor and rich widens and the quality of economic development is not good then the poor are more likely to overexploit natural resources and increases the carbon emissions, while the rich may not necessarily increase investment to improve the environment. Some recent studies (such as Khan & Yohang 2021; Adeleye et al. 2021 and Cui et al. 2021) have focused their enlarged consideration on the degrading the environment influenced by the distribution of wealth and income. An up-surging tendency in the disparity of income severely influenced poor or middle class of the society. The underprivileged and poor societies are very severely influence by an unbalanced distribution of income distribution subsequently they are mostly a susceptible portion of the society (Khan & Yohang, 2021).

3.2 Data

As the motive of current research is to explore the impact of income inequality and population density on the emissions of Carbon dioxide (CO_2). This study employed time series statistics spanning the years 1985 to 2020 to achieve this goal and the selection of this time series is mainly because data on variables is readily available from World Bank (WB) and World Inequality Database (WID). Carbon dioxide CO_2 emission taken as dependent variable while income inequality and population density taken as independent variables along with other independent variables like per capita GDP and urban population and GDP square. These explanatory variables will help to identify the objectives of this study.

This study built on secondary data and secondary data obtained from official institutions. The statistics on the emissions of carbon dioxide (CO_2), population density, GDP (Gross Domestic Product), GDP square and urban population was acquired from the World Bank. While income inequality data is collected from WID (World Inequality Database).

3.3 Econometric Model

In order to determine the link among variables, the following econometrics model or equation is used:

Where,

$$CO_2 = \beta_0 + \beta_1 IE + \beta_2 PD + \beta_3 GDP + \beta_4 (GDP)^2 + \beta_5 URB + \mu \qquad (1)$$

Where, CO2 represents the carbon dioxide emissions that is measured in metric tons per capita. IE represents income inequality and the proxy for this variable is top 10%, middle 50% and bottom 50%. PD represents the population density in per square kilometer. GDP represents Gross Domestic Product that is measured as constant 2015 US $. URB represents urban population that is measured in annual percentage.

The source of variables CO2 emissions, population density, GDP, GDP square and urban population is World Bank (WB). While the source of income inequality data is obtained from World Inequality Database (WID)

These other explanatory variables are used in different studies i.e., per capita GDP are used by Hundie (2021), Kusumawardani & Dewi (2020), Mushtaq et al. (2020), Jorgenson et al. (2017), Hailemariam et al. (2020). GDP square is used by Hundie (2021). Urban population is used by Jorgenson et al. (2017), Asongu et al. (2020).

3.4 Empirical Examination of Data

In order to proper investigating the model, the data are compiled, identified and reformed. Because time-based models elevated a variety of econometric challenges, suitablestrategies employed to overwhelm those problems. The model is expressing in a very suitable manner for econometric analysis. Several econometric techniques utilized to evaluate the parameters of the models, and to conclude the degree of correspondence of the model with reality as reflected by the data, various tests performed.

3.4.1 Explanation of Variables

3.4.1.1 Carbon dioxide (CO_2)

One of the greenhouse gases is carbon dioxide (CO2) that exists naturally in the atmosphere of Earth and an acidic colorless gas. Carbon emanations are to blame for the damage of an environment. In this study, carbon dioxide equivalent data CO_2e greenhouse gasses. Data taken from World Bank (WB) in metric tons per capita. This variable is using in previous research to quantify greenhouse gas emissions (Cui et al. 2021, S Khan & Yahong 2021, Islam et al. 2017 and Wang et al. 2021). Data taken from period 1985 to 2020.

3.4.1.2 Income inequality

Income inequality is unevenly distribution of income throughout a population. Income inequality is defined, as the income that is generating in a country cannot fairly distributed among regions, individuals or social classes (Uzar & Eyuboglu, 2019). If distribution of income is less equal, it means higher the income inequality and vice versa. This study has measured the impact of top 10%, middle 40% and bottom 50% of income distribution on carbon emissions. Data collected from World Inequality Database (WID). This variable used in various research such as Grunewald et al. (2017), Hundle. (2021), Baloch et al. (2017), Khan et al. (2021), Knight et al, (2017) and Yang et al. (2020). The data of this variable taken from 1985 to 2020.

3.4.1.3 Population Density

It is a number of individuals per km^2. It is a basic geographical term. Higher population density has definitely empowered the social and economic development, but higher population density increases the carbon dioxide emissions (Rahman et al., 2020)**.** Data of population density taken from World Bank (WB) from period 1985 to 2018. Population density used in various research e.g., Khan et al. (2021), Muhammad et al. (2020), Rahman et al. (2020) and Aye & Edoja (2017).

3.4.1.4 Gross Domestic Product (GDP)

GDP is a market value for all finished goods and services that are produce in a specific period and in a boarder of a country. In this study, the data for per capita GDP measured as constant 2015 US $ taken from World Bank (WB) from period 1985 to 2018. The variable per capita GDP used in much research i-e Khan et al. (2021), Kusumawardani & Dewi (2020), Osadume & University (2021) and Tanchangya & Zhou Ayoungman (2022).

3.4.1.5 Urban Population

Shifting of population from countryside to the cities is urbanization. Through urbanization, cities grow. Urbanization rate is a measure of population in cities. Rapid urbanization increases the environmental degradation. In Pakistan, there is a speedy urbanization because a shifting of inhabitants to urban areas from rural areas. Data taken from World Bank (WB) in annual percentage from period 1985 to period 2018. In this study, data for urban population is measured in percentage. This variable used in previous research that is Alabi et al. (2021), Khoshnevis & Dariani (2019) and Khan et al. (2017) to quantify greenhouse gas emissions.

3.4.2 Econometric Technique

Nature of data is time series. This study checked the unit root test of all mentioned variables and then applied the certain econometric technique. Augmented Dicky Fuller (ADF) test applied to measure the stationarity to assess as the variables of interest are stationary at level 1st difference. After estimations of stationarity, if all the variables are stationary at level, then Ordinary Least Square (OLS) regression technique applied but if the variables are not stationarity, then there are few techniques are available such as Johansen approach, Engle Granger approach and Autoregressive Distributive Lag ARDL approach.

Using the Augmented Dickey Fuller unit root test, the variables tested for stationary levels, and at different orders of integration, they found to be stationary, necessitating the hiring of the ARDL estimation method. Moreover, to avoid the problem of multi-collinearity between variables a correlation analysis performed that included in the estimated econometric model. The Akaike information criteria (AIC) applied to recognize the appropriate lag length for the estimation of model, and the ARDL bound test used to approve if there was a long-term connection amongst carbon emissions and the definite variables.

After estimating the model and after obtaining the coefficients of variable, this study conducted post-estimation evaluations to affirm the validity of the model that is estimated, confirming that the underlying assumptions were not violated and the validity of the technique of estimation used, and the conclusions drawn therefrom. To evaluate the stability, the CUSUM test used, the Jarque-Bera test used to conclude the normality, the ARCH-LM test applied to determine the heteroscedasticity, and the Breusch-Godfrey test applied to determine the serial correlation.

3.4.2.1 Unit Root Results

Starting from the unit root test, verify the unit root of the series, the augmented dicky fuller test is applied. On the log of all variables, which uses both trend and constant. The series is non-stationary if a series has unit root i-e not stationary at level. If it is stationary of the same order i-e 1, 1 and their linear combination is integrating of the order that is less than the order of the variables, then among the variables, it suggests that there may be, a long-term relationship. Lag differences are the indispensable portion of Augmented Dicky Fuller (ADF) test to evade the serial correlation problematic. To define the optimal level of lags, the minimum Akaike Information Criterion (AIC) is used.

Augmented Dicky Fuller

Augmented Dicky Fuller (ADF) test is using by current study to evaluate for the time series' Nonlinear Autoregressive Distributive Lag stationary features, t-ratio of a regression is used. The

Augmented Dicky Fuller (ADF) test contains a lagged term for the dependent variable to decrease autocorrelation. By using the following hypothesis.

HO: non-stationary series.

H1: The series is stationary

$(CO_2)\ t = \alpha\ (CO_2)_{t-1} + \varepsilon_t$ (2)

If α = 1, then the regression equation is,

$\Delta\ (CO_2)_t = \omega\ (CO_2)_{t-1} + \varepsilon t$ (3)

Where, $\omega = \alpha - 1$

Whereas ε is the error term and ε should be pure white noise process while α is a coefficient.

$\Delta\ (CO_2)_t$ is the first difference of carbon emission.

T test = ω / (ω)

The null hypothesis is not rejecting if the t statistics is smaller than the critical value.

If there is, no stationarity in a series data some methods will used to correct it. By using trend stationarity, trend variables of time series is involved as an independent variable. The term 'De-trending' used for this technique. To get rid of non-stationarity, another way is difference stationarity. Between the variables, this is a procedure of determining the first difference. Testing for co-integration is another way to the first difference technique.

3.4.2.2 Information Criteria (Lag length Selection)

Based on a multiplicity of information criteria, models are selecting.

To conclude the number of repressors added to the model, following factor is used.

(AIC) Akaik information Criteria = ln AIC = (2k/n) + ln (RSS/n)

3.4.2.3 ARDL bounds testing approach

The approach of ARDL bound testing was introduced by Pesaran, Shin, and Smith (2001) used by current paper to assess for co-integration and between the variables, evaluate the long-term relationship. The procedure of ARDL delivers strong evaluations by effectually cooperative endogeneity amongst the variables, overwhelms the problem of serial correlation, and utilizes the suitable selection of lag. Sizes of small sample may be suitable for autoregressive-distributed lag When they are integrating by using a mixed order of integration such as I (0) or I (1), additionally to the fact that it yields higher results for finite time series for data samples.

ARDL form is model as follows,

$$(CO_2)_t = \beta_0 + \beta_t (CO_2)_{t-1} + \cdots + \beta_p (CO_2)_{t-p} + \alpha_t IE_t + \alpha_t IE_{t-1} + \cdots + \alpha_q IE_{t-q} + \gamma_t PD_t + \gamma_t PD_{t-1} + \cdots + \gamma_m PD_{t-m} + \delta_t GDP_t + \delta_t GDP_{t-1} + \cdots + \delta_n GDP_{t-n} + \eta_t (GDP)^2_t + \eta_t (GDP)^2_{t-1} + \ldots + \eta_n (GDP)^2_{t-n} + \theta_t URB_t + \theta_t URB_{t-1} + \cdots + \theta_j URB_{t-j} \quad (4)$$

Where,

CO_2 = Carbon dioxide emissions, IE = Income Inequality, PD = Population Density, GDP = Gross Domestic Product, GDP^2 = Gross Domestic Product square, URB = Urban population

3.4.2.4 Lag Selection

The ARDL bounds testing method concludes the number of regressions that used to help with lag selection.

3.4.2.5 Co-integration

There are many methods are available for co-integration; Engle-Granger single equation two -step co-integration approach, multiple equation Johansen co-integration method, and the approach of ARDL single equation are the most common among them. In this study, there is a need to assess the long-run determinants, so there is no need to apply the Johansen approach. The ARDL approach produce a reliable evaluate of the long -run coefficients regardless of the order of integration of variables, such as, they are integrated of order one, I(1), or zero, I(0) [Pesaran and Shin (1997)]. By using the following Equation (8), the long-run equations are estimate and F-statistic is used to assess the importance of variables in lag level forms. i.e., Ho is $\beta 1 = \beta 2 = 0$. There may exist a long-run relation within the variables if F-statistic is significant. The variables of long-run are determined by using the F-statistic in the lag level forms to joint check the significance of the variables, i.e., Ho is 1 = 2 = 0. Whereas if F-statistic is significant, it means there is a long-term correlation within the variables.

3.4.2.6 ARDL Approach to Co-integration

Co-integration recommends a collection of dynamic long-run equilibria because the weights required to establish stationarity reflect the parameters of the equilibrium relation among the variables that are in interest. For evaluating co-integration, Pesaran and Shin (1996), Pesaran and Pesaran (1997), Pesaran and Smith (1998), and Pesaran, Shin, and Smith (2001) that created the "autoregressive distributed lag (ARDL)"-bound test. When integrated series of order 1 or I is dealing, this procedure (ARDL) has numerous benefits over the Johansen co-integration technique, which is concerned with integrated series of order 1 or I. (1), this technique reflected the most exact tactic to use.

The ARDL approach does not have the same pre-testing problems as traditional co-integration, that needs the variables to be label as I (1) or I (0) before testing (Pesaran et al., 2001). The ARDL technique, according to Pesaran and Pesaran (1997), is a two-step procedure. At the initial stage, to evaluate if there is some long-term relation amid the variables of interest then F-test is used. Secondly, the study requires approximating the long-run relationship coefficients, followed by estimating the short-run elasticity of the variables by using the error correlation coefficient.

The critical bounds, the upper critical bound (UCB) and the lower critical bound (LCB) used to test for co-integration defined by Pesaran et al. (1999). The null hypothesis created is $H0 : \beta_t = \alpha_t = \gamma_t = \delta_t = \theta_t$, if it holds then among the variables there is no co-integration. If the substitute hypothesis: $\beta_t \neq \alpha_t \neq \gamma_t \neq \delta_t \neq \theta_t$ is true, then there exists co-integration.

In hypothesis testing, the upper critical bound (UCB) and lower critical bound (LCB) are used. Accept the alternative hypothesis and negates the null hypothesis if the F-statistics obtained are more than the upper critical bound (UCB).

3.4.2.7 Error Correction Mechanism (ECM)

The study uses the Error Correction Mechanism (ECM) after the establishment of co-integration. After a change in endogenous variables or independent variables, this model evaluates the speed at which the independent variable CO_2, in our case carbon emissions, returns to equilibrium. Because data is not using in the first difference, without losing information about long run results, it also mergers short run and long run relationships.

The error - correcting model's equation is as follows:

$$\Delta (CO_2)_t = \sum_{t=0}^{p} \beta_t \Delta (CO_2)_{t-1} + \sum_{t=0}^{q} \alpha_t \Delta IE_{t-1} + \sum_{t=0}^{m} \gamma_t PD_{t-1} + \sum_{t=0}^{n} \delta_t \Delta GDP_{t-1} + \sum_{t=0}^{j} \eta_t (GDP)^2 + \sum_{t=0}^{k} \theta_t \Delta URB_{t-1} + \varphi ECT + \varepsilon_t \quad \ldots\ldots\ldots\ldots \quad (5)$$

Where ECT is an error correction term that denotes the speed, with which a system adjusts from a short-run disequilibrium to equilibrium of long-run.

Unrestricted equations are as follows:

$$\Delta CO2t = ao + \alpha 1t + \sum_{i=1}^{m} \alpha 2i \Delta CO2t - i + \sum_{i=0}^{n} \alpha 3i \Delta IEt - i + \sum_{i=0}^{n} \alpha 4i \Delta PDt - i + \sum_{i=0}^{n} \alpha 5i \Delta GDPt - i + \sum_{i=0}^{n} \alpha 6i \Delta (GDP)2t - i + \sum_{i=0}^{n} \alpha 7i \Delta URBt - i + \alpha 8CO2t - 1 + \alpha 9IEt - 1 + \alpha 10PDt - 1 + \alpha 11GDPt - 1 + \alpha 12URBt - 1 + \mu 1t \quad (6)$$

$$\Delta IEt = \beta o + \beta 1t + \sum_{i=1}^{m} \beta 2i \Delta IEt - i + \sum_{i=0}^{n} \beta 3i \Delta CO2t - i + \sum_{i=0}^{n} \beta 4i \Delta PDt - i + \sum_{i=0}^{n} \beta 5i \Delta GDPt - i + \sum_{i=0}^{n} \alpha 6i \Delta (GDP)t - i + \sum_{i=0}^{n} \beta 7i \Delta URBt - i + \beta 8IEt - 1 + \beta 9CO2t - 1 + \beta 10PDt - 1 + \beta 11GDPt - 1 + \beta 12URBt - 1 + \mu 2t \quad (7)$$

$$\Delta PDt = \gamma o + \gamma 1t + \sum_{i=1}^{m} \gamma 2i \Delta PDt - i + \sum_{i=0}^{n} \gamma 3i \Delta CO2t - i + \sum_{i=0}^{n} \gamma 4i \Delta IEt - i + \sum_{i=0}^{n} \gamma 5i \Delta GDPt - i + \sum_{i=0}^{n} \alpha 6i \Delta (GDP)t - i + \sum_{i=0}^{n} \gamma 7i \Delta URBt - i + \gamma 8PDt - 1 + \gamma 9CO2t - 1 + \gamma 10IEt - 1 + \gamma 11GDPt - 1 + \gamma 12URBt - 1 + \mu 3t \quad (8)$$

$$\Delta GDP\text{t} = \delta o + \delta 1t + \sum_{i=1}^{m} \delta 2i\Delta GDP\text{t} - \text{i} + \sum_{i=0}^{n} \delta 3i\Delta CO2\text{t} - \text{i} + \sum_{i=0}^{n} \delta 4i\Delta IE\text{t} - \text{i} + \sum_{i=0}^{n} \alpha 5i\Delta(GDP)\text{t} - \text{i} + \sum_{i=0}^{n} \delta 6i\Delta PD\text{t} - \text{i} + \sum_{i=0}^{n} \delta 7i\Delta URB\text{t} - \text{i} + \delta 8GDPt - 1 + \delta 9CO2t - 1 + \delta 10IEt - 1 + \delta 11PDt - 1 + \delta 12URBt - 1 + \mu 4t \quad (9)$$

$$\Delta(GDP)2\text{t} = \delta o + \delta 1t + \sum_{i=1}^{m} \delta 2i\Delta GDP2\text{t} - \text{i} + \sum_{i=0}^{n} \delta 3i\Delta CO2\text{t} - \text{i} + \sum_{i=0}^{n} \delta 4i\Delta IE\text{t} - \text{i} + \sum_{i=0}^{n} \delta 5i\Delta PD\text{t} - \text{i} + \sum_{i=0}^{n} \delta 6i\Delta GDP\text{t} - \text{i} + \sum_{i=0}^{n} \delta 7i\Delta URB\text{t} - \text{i} + \delta 8GDPt - 1 + \delta 9CO2t - 1 + \delta 10IEt - 1 + \delta 11PDt - 1 + \delta 12URBt - 1 + \mu 5t \quad (10)$$

$$\Delta URB\text{t} = \theta o + \theta 1t + \sum_{i=1}^{m} \theta 2i\Delta URB\text{t} - \text{i} + \sum_{i=0}^{n} \theta 3i\Delta CO2\text{t} - \text{i} + \sum_{i=0}^{n} \theta 4i\Delta IE\text{t} - \text{i} + \sum_{i=0}^{n} \theta 5i\Delta PD\text{t} - \text{i} + \sum_{i=0}^{n} \theta 6i\Delta GDP\text{t} - \text{i} + \theta 7URBt - 1 + \theta 8CO2t - 1 + \theta 9IEt - 1 + \theta 10PDt - 1 + \theta 11GDPt - 1 + \mu 6t \quad (11)$$

3.4.2.8 Diagnostic Test

Diagnostic test conducted to model specification problem, serial correlation problem and normality in the residuals.

3.4.2.9 Serial Correlation LM Test

The Breusch–Godfrey test is a statistical test that is used to conclude the validity of specific modelling assumptions made when applying regression-like models to the data of observation. It looks for serial correlation (When an error in one period that correlates with an errors in the other periods, this is known as serial correlation) that has not been involved in the recommended model's structure and, if found, could lead to inexact findings drawn from other tests or sub-optimal model parameter values conquered. Those scenarios in which the dependent variables' lagged values are use as independent variables in the formulation of a model for future observations are among the regression models to which a study's test can be apply. The Breusch–Godfrey test looks for autocorrelation in results of regression model. To calculate a test statistic, it uses the residuals from the model under contemplation in a regression analysis.

According to the null hypothesis, any order up to p there is no serial correlation. For serial correlation, the test is commonly referred to as an LM test because it based on the Lagrange multiplier-testing concept.

3.4.3.10 Stability Test

To assess the stability of model, Stability Test is conducting.

In a model of multiple linear regression $y = X\beta + \varepsilon$. To determine the stability of coefficients (β), CUSUM tests are used. The inference is center on a series of sums, or sums of squares, for recursive residuals (standardized one-step-ahead errors of forecast), which are repeatedly generate from nested sub - samples of datasets.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Unit Root Test Results

Already evaluating the long run and short run dynamics of the model, to assess the level of stationarity, current research use unit root tests in each series. To assess the problem of unit root, the paper uses the conventional Augmented Dickey Fuller (ADF) test with two specifications: With intercept only “at level” [I (0)] and at “first difference” [I (1)]. Table 01 (displayed in appendix) shows the consequences of the test, which shows that at level all of the variables are stationary. The calculated ADF values of the variables are showing in the table (displayed in appendix) with their probability values (P-Value). ARDL approach used as all variables at level are stationery and 1^{st} difference so for analysis. Carbon emissions, income disparity for top 10%, middle 40% and bottom 50%, density of population, GDP per capita, GDP square and urban population all these variables are covering the time series data for the years 1985 to 2020.

As confirmed by ADF test, starting with carbon emission and income inequality for bottom 50% and GDP square are integrating at order one and income inequality top 10%, middle 40%, population density, gross domestic product and urban population, they are integrating of order zero. This stationary test of variables is also satisfying the situation that there is no variable that is integrating of order two [I (2)] before applying the approach ARDL.

The result shows that variables carbon emission and income inequality for bottom 50% and GDP square had unit root at first difference means at level they are not stationary. While income inequality top 10%, middle 40%, population density, gross domestic product and urban population these are the variables that are stationary at level. The following table shows the estimated results.

Table 4.1

Unit root results of stationarity

Variables	Augmented Dicky Fuller (ADF) At Level t-statistic	Augmented Dicky Fuller (ADF) 1st Difference t-statistic	Probability Value (P-Value)	Order of integration
Carbon Emission ($CO2$)	----	-4.499915	0.0013	I(1)
Income Inequality Top 10% (IE)	-3.008936	----	0.0441	I(0)
Income Inequality Middle 40% (IE)	-2.677192	----	0.0884	I(1)
Income Inequality bottom 50% (IE)	----	-3.385672	0.0186	I(1)
Population Density (PD)	-3.686204	----	0.0363	I(0)
Gross Domestic Product (GDP)	-4.056750	----	0.0031	I(0)
Gross Domestic Product square (GDP^2)	----	-4.789942	0.0012	I(1)
Urban Population (URB)	-8.439992	----	0.0000	I(0)

To estimate the model, current study has chosen the approach of Autoregressive Distributed Lag (ARDL) to the technique of co-integration after checking the stationary of all the variables.

4.2 Results of Bound Test

A bound test is essential for identify the presence of co-integration amid variables of this study. The current study perform the procedure of bounds co-integration testing by applying F-statistics to recognize as the variables that are selected are co-integrating in the long run or not.

The determined F-statistic value (7.766755) estimated with the crucial values with the lag order length of 4. If the value of determined F-statistic is upper than the critical value of the upper bound, then this recommends that there is a long-term relation occurs amid the dependent variable and its determinants. On the contrary, if the value of determined F-statistic is lower than the critical value of lower bound, then this recommends that the series are not linked together. Lastly, implication about the co-integration would be inconclusive but if the calculated F-statistic falls within the bound critical value.

The calculated F-values and the level of significance that is (10, 5, 2.5, and 1%), beside with lower I (0), and lower I (1) critical values. The tabulated or fixed values of the upper bound that is I (1) are fewer than that of the computed F-values; even at 1% (0.1) level, they are highly significant. This provides sufficient evidence to negate or disregard the null hypotheses of no co-integration and recommends that there exists a long-term relation. Therefore, we can determine that among variables there is a long-term relation. This process demonstrated that income inequality, size of population, GDP (per-capita), GDP square and urban population, and the emanations of carbon all have a deep connection.

This section includes both long-run and short-run experimental evidence; in Pakistan, this study employed the ARDL approach to quantify the relation amid income inequality, size of population, GDP per capita, GDP square and urban population, and emanations of carbon. In current study, mostly variables that are using in the model have converted into log form.

4.3 The Long Run Coefficients

The procedure of ARDL certifies the prospect to evaluate the long-term relation amongst variables. Current procedure was preferred as it has the aptitude to evaluate the counteraction of variables when they are integrated by utilizing a varied order of integration for example I(0) or I(1). For the investigation of co-integration, lag lengths are very important. After the confirmation of co-integration, the selected model of ARDL is using to evaluate the long run coefficients.

Table 4.2: *Long-run ARDL results*

Variables	Coefficients	t-statistics	P-value
I.E Top 10%	3.970932	2.960721	0.0138
I.E Middle 40%	2.260352	3.015679	0.0080
I.E Bottom 50%	2.895955	2.606050	0.0165
P.D	0.013642	2.929674	0.0080
GDP	0.132937	3.044239	0.0062
GDP^2	-0.105233	-8.353006	0.0034
URB	0.307151	3.456691	0.0024

Source: Authors' own estimations

Detailed evidence of the long run that are presenting in Table 4.2. The estimated outcomes illustrate that in the model, carbon emissions has a positive or direct and strong impact on all variables. The outcomes of long run suggest that in Pakistan higher level of carbon emissions are relating with a greater income inequality and higher population density. Many researchers have also proved the direct connection among carbon emissions and income inequality and population density e.g., Khan et al. (2021) proposes a direct influence of poverty, growth of an economy and population on the emissions of carbon in Pakistan but there is an indirect Inequality of income has an influence on the emanations of carbon. Baloch et al. (2020) evaluate that an upsurge in income inequality upsurges the emanations of carbon dioxide (CO2). Baloch et al. (2017) investigate that the negative affect of population density and industrial share on CO2 emissions. Muhammad et al. (2020) shows that in Pakistan, consumption of energy and size of population are contributing emanations of carbon.

The positive effect of economic growth on carbon emissions is attributable to the fact that at the early stage of development of an economy, developing countries often ignore the possible negative effects of economic growth on the environment (Khan, 2019). Moreover, at an early stage of the process of economic development, industrialization increases and developing countries have weak environmental regulations to control emissions from the increasing industrialization. The coefficient of economic growth squared is negative and statistically significant. In Pakistan, a 1% increase in economic growth squared will decrease CO2 emissions, keeping other things constant. It shows that countries are concerned to lessen environmental degradation after they achieve a certain development level. The results from ARDL confirms that effect of economic growth on environmental quality follows the EKC hypothesis. This is consistent with the finds of Hundie (2018) for Ethiopia and Kusumawardani and Dewi (2020) for Indonesia.

4.3.1 Population Density and Carbon Emissions

In terms of population, the ARDL study reveals that there is a strong and highly significant association among both size of the population and destruction of the environment. As a final recommendation, it can be concluded that population growth is a major component of environmental deterioration in Pakistan. One possible explanation is that as the population grows, so does the number of people, and as the number of people grows, so does the need for more resources, and as the number of people grows, so does the need for more transportation. As a result, the earth's natural resources are depleting at an increasing rate. The principal consequence of resource depletion is biodiversity loss and deforestation, as humans deplete the resources of earth to accommodate an ever-increasing population. Carbon dioxide emissions, which affect the climate, tend to rise as a result of population growth and rising consumption. Rapid population growth stresses resources and increases exposure to climate-related dangers, especially in low-resource areas, worsening the effects of climate change. The conclusions of this research, encouraged by the efforts of Muhammad et al. (2020) which shows that in Pakistan, consumption of energy and population density are contributing carbon emissions. Khan et al. (2021) recommends a direct influence of poverty, growth of an economy and population on the emissions of carbon in Pakistan. Zarco-Periñán et al. (2021) recommends that when the density of population is getting higher then higher the emanations of carbon. However, this study is not supported the study of Baloch et al. (2017) which investigate that the negative influence of population density and industrial share on CO2 emissions.

4.3.2 Income Inequality and Carbon Emissions

The resulting coefficients of inequality of income on the emissions of carbon recommend a direct and strong impact on the degradation of environment, that is, in income inequality the positive trend leads to upsurge in the emanations of carbon. In other words, in Pakistan higher the inequality of income it means higher the degradation of environment. The outcome of the present research is reliable with the outcomes of empirical research of Uddin et al. (2020) for the number of countries in the Group of Seven (G7), Wang and Ye (2017) for China, Grunewald et al. (2017) for the nations of Third World. However, current research is not supported the work of Khan et al. (2021) who suggest that there is a negative or indirect relation among inequality of income and the emanations of carbon. Hailemariam et al. (2020) verified that broader disparity of income diminishes in degrading the environment.

4.3.3 GDP and Carbon Emissions

The outcomes from ARDL method illustrate that there is a direct and strong relation among GDP (Gross Domestic Product) per capita and the degrading the environment in the case study of Pakistan, accordingly, representing that the GDP per capita increases carbon emission in the short-run and in the long-run also. Higher level of economic activities tend to increase consumption of natural resources and energy use so, growth of an economy upsurges the carbon emissions in Pakistan. Mainly, the conclusion of current research is similar with the effort of Khan et al. (2021) investigates that GDP per capita upsurge the emissions of carbon in both long-run and short run and Hassan et al. (2015) shows that there is a direct connection amid GDP and the emissions of carbon dioxide. Islam et al. (2017), investigate that as GDP per capita in a country increases then it means carbon emission also increases, there is a direct relation among GDPs per capita and the emissions of carbon.

4.3.4 Urban Population and Carbon Emissions

The outcomes from the methodology ARDL illustrate that there is a direct and statistically strong relation among urban population and carbon emissions in case of Pakistan. Cities grow due to urbanization. Cities are congested their roads are also congested, there is a lot of traffic in cities, when there is more urbanization it means more people demand a greater number of vehicles. Therefore, this is the reason when urban population increases then the carbon emissions also increases. The current study is comparable with the work of Hundie (n.d.) investigate that urbanization is positively or directly contribute to the degradation of environment in Ethiopia by 0.11% and Khoshnevis & Dariani (2019) shows that urbanization increases the emissions of carbon it means there is a direct association among urbanization and the emissions of carbon dioxide.

Table 4.3: *Error Correction Representation for the Selected ARDL Model*

Variables	Coefficient	t-statistics	P-value
$\Delta \ln (CO2)_{t-1}$	1.4673267	12.269732	0.0001
$\Delta \ln GDP$	-0.324423	-2.923765	0.0326
$\Delta \ln (GDP)_{t-1}$	-3.078632	-23.17624	0.0003
$\Delta \ln (GDP)_{t-2}$	-2.876342	-15.87354	0.0004
$\Delta \ln (GDP)^2$	0.017923	1.437652	0.1153
$\Delta \ln (GDP)^2_{t-1}$	0.261725	25.72564	0.0001
$\Delta \ln (GDP)^2_{t-2}$	0.167432	16.79873	0.0004
Δln (I.E Top 10%)	-0.287621	-9.228721	0.0011
Δln (I.E Top 10%)$_{t-1}$	-0.432661	-9.287381	0.0002
Δln (I.E Top 10%)$_{t-2}$	0.176254	20.27652	0.0032
Δln (I.E Middle 40%)	-0.336721	-6.263728	0.0001
Δln (I.E Middle 40%)$_{t-1}$	-0.238624	-6.736464	0.0021
Δln (I.E Middle 40%)$_{t-2}$	0.326511	22.78686	0.0062
Δln (I.E Bottom 50%)	-0.116252	-8.786381	0.0037
Δln (I.E Bottom 50%)$_{t-1}$	-0.167382	-7.987321	0.0001
Δln (I.E Bottom 50%)$_{t-2}$	0.272635	21.78563	0.0072
$\Delta \ln (PD)$	1.278934	24.28651	0.0001
$\Delta \ln (PD)_{t-1}$	0.562966	6.046238	0.0002
$\Delta \ln (PD)_{t-2}$	-2.834216	-4.107621	0.0059
$\Delta \ln (URB)$	-0.523763	-2.991243	0.0022
$\Delta \ln (URB)_{t-1}$	4.062389	22.997832	0.0022
$\Delta \ln (URB)_{t-2}$	7.319251	22.043281	0.0022
ECT_{t-1}	-0.432170	-4..87656	0.0062

The error-correction representation of the ARDL model is given in above table. The result shows that all predictors and their lagged values affect the dynamics of CO2 emissions in Pakistan during 1985–2020.

This study performed diagnostic testing procedures such as serial correlation (Breusch-Godfrey Serial Correlation LM Test) and heteroscedasticity test (Breusch Pagan Godfrey), after finishing the evaluation process for the long-term.

4.4 Diagnostic Test

After inspecting the long-term relation among the variables of current research, a diagnostic test like serial correlation LM test, is also conducting to confirm the robustness of outcomes. The model's dependability, sensitivity and righteousness have all tested by using diagnostic tests and stability tests. Serial correlation (that is, when a variable and even a lag version of its own are seen to be interrelated with each other over time, in a time series this is known as serial correlation) postures a risk to econometric models. As a result, the Breusch Godfrey LM Test employed to see if the estimated model had any serial correlation or not. When the probability level was higher than the permissible limit of 5% then the null hypothesis of "serial correlation" rejected. Now current research used Breusch Godfrey LM Test to test the serial correlation.

Table 4.3

Estimated results of Serial Correlation

F-statistic	Prob. F(2,19)	Obs*R-squared	Prob. Chi-Square(2)
0.712875	0.5029	2.512858	0.2847

Source: Authors’ own estimations

The observed R-squared probability Chi-Square is 0.2847 that is greater than 0.05.

The null hypothesis: serial correlation

By using Breusch-Godfrey Serial Correlation LM Test, the null hypothesis posits that the data serially correlated. Therefore, from the estimations that are mentioned above, the observed R-squared probability Chi-Square is 0.2847 that is greater than 0.05. Therefore, consequently, this null hypothesis was rejected, indicating that in the data there is no serial correlation present.

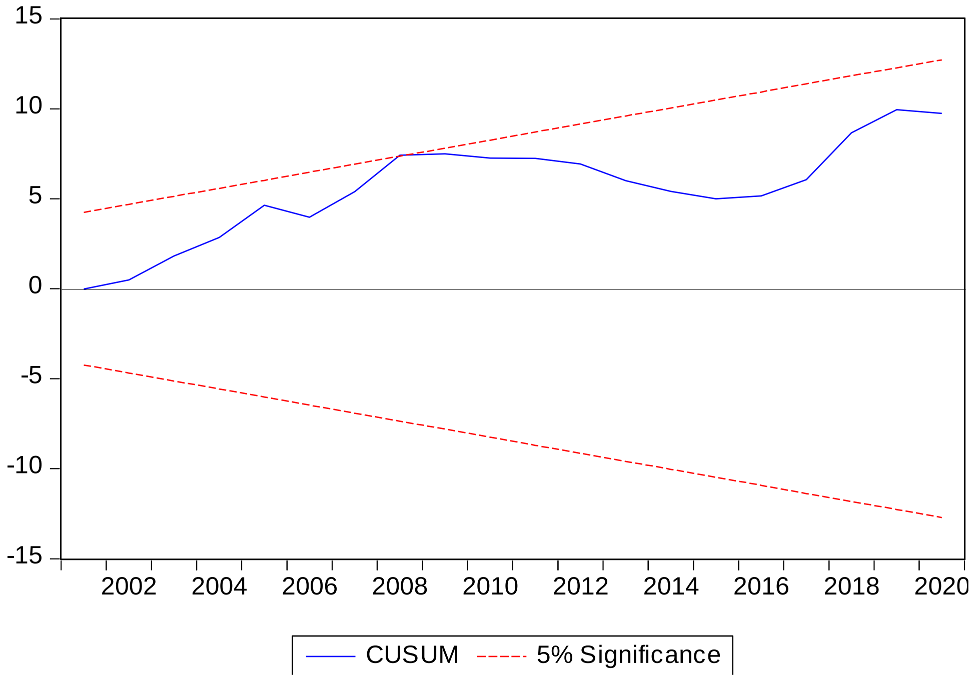
According to the analysis, there exist no correlation among the variables. The following studies provide additional proof. These variables are use together, like population density and urban population, by Rahman & Alam (2021), Haimeng et al. (2018), and Liu et al. (2017), therefore according to these studies there is no correlation between them.

Current study also evaluate the consequences of heteroscedasticity by utilizing Breusch Pagan Godfrey, the chi-square is 0.2647 that is greater than 0.05, which indicates that, the absence of heteroscedasticity. The estimated table displayed in the appendix.

4.5 Results of Stability test

Finally, recursive estimations by using CUSUM and CUSUM square tests (Figs.1, 2) found that the parameters for the estimated model remain steady over the course of this study because two recursive lines exist in the bound, indicating that in the model of error-correction, all coefficients are steady at the 5% significance level. The CUSUM test was used to verify the stability of the estimated ARDL model, and the results validated the model's stability, indicating that it was well characterizing the data. The stability testing is used to assess parameter stability. The conclusion about the stability of the parameter based on the position of the plot in relation to the 5% critical constraint.

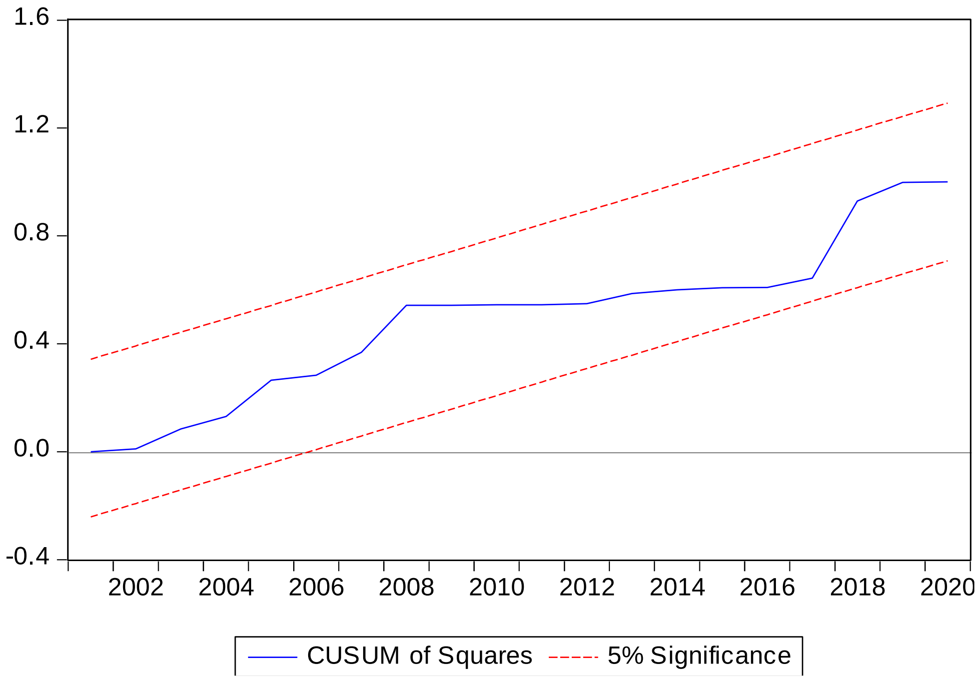
Figure 4.5.1: *CUSUM of Recursive Residuals*



Plot of Cumulative Sum of Squares of Recursive Residuals

Figure 4.5.2

CUSUMQ of Recursive Residuals



The CUSUM and CUSUMSQ statistics are using in current study. If the graph of the CUSUM or CUSUMSQ remain within the region amongst the two crucial lines for the course of the present investigation, the model's parameters are steady. Figures 2 and 3 reveal the results of the stability test. It shows that the directions of both the CUSUM and CUSUMSQ graph remain within the region between the two crucial lines, indicating that the parameters are stable through the research period. In other words, in the model there exist no structural changes.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

To attain a current study goals or objectives, the outcomes of this research provide a substantial insight by examining the connection amid population density, income inequality, and carbon emissions, including GDP, GDP square and urban population in the model by using the data of time-series from time period 1985 to 2020 for Pakistan. The motive of our study is to attain reliable regression outcomes. The acquired outcomes of this study shortened, in the case of Pakistan, as population density and income inequality are the main forecaster of the emanations of carbon. The population of cities and GDP per capita are also risky for the environmental protection in Pakistan. It will be calmer to manage with up surging the temperatures, enhance sustainability of urban, and enhance air quality in urban areas if we have a good understanding of the existing condition of energy usage and pollutants in cities (Zarco-Periñán et al. 2021)

The results of this research found that the population density and income inequality are key aspects in determining the emanations of carbon in Pakistan as the emanations of carbon dioxide (CO_2) is the huge contribution in the destruction of the environment. In addition, due to speedy urbanization and up surging the expansion of a population, the climate of the world is growing at an incredible rate, which are, badly disturbing the environment, that is against the maintainable goals.

The impact of economic growth on CO2 emissions in Pakistan is an inverted U-shape supporting the EKC hypothesis during the study period. This suggests that economic growth takes place at the expense of environmental degradation during the early stage of economic development process. Economic growth then improves the quality of environment in later stage of development process once a certain level of development is achieved.

The outcomes illustrate that there is a direct or strong connotation amongst carbon emissions and population density. Therefore, there is a direct relation among population density and the emissions of carbon. From such consequences, it is inferred that in Pakistan population is the leading cause to the environmental degradation. Higher density of population has definitely enabled economic and social development, but higher population density upsurges the emissions of carbon (Rahman et al., 2020). The consequences of this research also demonstrate that there is a positive and direct relation amid the emanations of carbon and the inequality of income. As income, inequality increases carbon emissions also increases. Higher income inequality can hypothetically worsen the degradation of environment because when there is high-income inequality, it is claim that needy people tend to over exploit natural resources that they recognize it as a final effort to stay alive. Therefore, higher the level of Inequality of income correlated to higher emanations of carbon. An up-surging tendency in the disparity of income that has desperately distresses different economic classes of the society. The deprived and poor societies are very desperately pretentious by an unbalance distribution of income subsequently they are primarily a susceptible portion of the society (Khan & Yohang, 2021).

As, high population density and income inequality are harmful factors for degrading the environment. Moreover, an upsurge in the GDP per capita and urban population increases the carbon emissions as well. Therefore, there exist a direct relationship of carbon emissions with urban population and GDP per capita. As more people are coming to urban areas from rural areas for seeking better opportunities. Due to which urban population is increasing day by day, which tend to increase the carbon emissions. The consumption pattern for fuel and energy has altered as urban lifestyles have improved. Due to the growth of population and urban sprawl, the need for vehicles for household purposes is increasing, which causes an upsurge in the volume of traffic. Among GDPs per capita and carbon emissions, there exist significant and positive connection because as economic growth of a country increases carbon emissions also increases. When economic growth increases it means there are higher level of economic activities in a country that become the reason of additional use of energy and consumption of natural resources as energy consumption is closely related to carbon emissions. Therefore, as economic growth increases then there is also increase in the carbon emissions that shows positive or direct and significant relation.

To limit environmental degradation, Pakistan's government or authorities should take several critical actions based on the outcomes of their policies involving the decline of economic inequality and population size, as well as a sustainable GDP and urban population strategy.

5.2 Policy Implications

The policy implications of this research based on the preceding findings. To de-carbonize the economy, Pakistan must focus on policies that are more efficient. Environmental levies and incentives for the usage of clean energy can help this process succeed. This study recommends that in Pakistan, high population density and income inequality are the key interpreter that are degrading the condition of the environment. As a response, officials must plan their policies to diminish population density and income inequality level. Concerning policy implementation, for policy makers, the current paper's outcomes reflected a few key long, medium, and short-term ramifications. From the consequence of this paper, the policymakers might suppose steps that can improve the intensity of income inequality and population density that may have a growing or increasing effect on the emissions of carbon.

- The concerned authorities and the government should develop a detailed policy to ensure that the benefits of all economic and productive endeavors reach the poor and needy individuals. In Pakistan, productive things, as well as the economic development of the country and growth are detrimental to the environment's integrity. As a result, governments should think about high growth of an economy as well as focus on the quality of the environment. To attain sustainable MDG (Millennium Development Goals) and economic growth, such policies should be implemented by the Pakistani government for the regulation of environment and confirm the practice the energy of friendly environment. Therefore, the regulatory policy about the protection of environment significantly boosts the innovation process that in turn reduce the carbon emissions. The government of Pakistan should build factories outside of cities so that big and heavy automobiles and Lorries with excessive diesel intakes cannot enter or travel through cities. Carbon emanations can be diminished by adopting these strategies. The government should tax cars that emit carbon and pollute the environment. Through social media, the government should educate Pakistanis about appropriate car maintenance.
- The results of current study show that fair income distribution can minimize carbon emission. One of the most necessary aims for the development of an economy is to eradicate income disparity. For policy implications in the immediate term, Pakistani government officials who are concerned should make sure that the needy and low-income collection of individuals should not convert their requirements into greater carbon emissions. The government and policymakers of an economy, to achieve stability,

guarantee a distribution policy and an equal distribution of revenue and control carbon emissions, which in turn enhance the quality of environment. Moreover, policies should be implemented to increase minimum wage and for working families, to support accumulating assets can narrow the income gap. Furthermore, for policymakers it is recommended that to take into consideration friendly working environment-related regulations, so that low-income workers can make their best effort to work efficiently and earn more, when they will earn more, they will be able to purchase more sophisticated appliances and maintain their car's maintenance which will keep it running more efficient. Which in turn diminishes emanations of carbon. The government policies of Pakistan concerning the income distribution can used to protect the atmosphere from carbon emission and they should provide clean energy environment. Subsidies are also provided to poor individuals from government officials.

- To de-carbonize the environment in urban society, government should plan housing societies and to control carbon emissions by private sector housing initiatives government can employ strict regulations.
- It is necessary in Pakistan to undertake the detailed policy measures that can be able to regulate the evolution of population, as an increase size of household is likely to have caused raised in the level of carbon emissions because urban households definitely may have greater demand for energy as compared to the household for rural areas. Energy in the form of electricity, gas and oil is an unavoidable necessity for the population of metropolitan areas, whether for cooking sewage, water supply, transportation, communication and information technology, or the construction of services and infrastructure to improve quality of life. There are various recommendations that could use

to minimize the GHG emissions from household level. Electrical appliances that are energy efficient and innovative should be used in everyday life and for that purpose, government should provide subsidies in that advanced electrical appliance for poor people due to those emissions of greenhouse gas GHG could decrease. The usage of old or used electrical equipment should be prohibit in order to lessening carbon emissions in cities. System of potential public transport should plan to lessen the reliance on private transportation such as motorcycles and automobiles, which aim to decrease carbon dioxide emissions in urban areas. Government should reduce the rates for Metro bus so that poor people can easily use transport. Moreover, for future mitigation of carbon emissions, awareness initiatives of causes and effects for changing the climate should be widely promoted.

Future Research Direction

Future studies in this domain can investigate the impact of income inequality and population density on carbon emissions in Pakistan to compare the relative effectiveness of carbon emissions across different regions.

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APPENDIX

Table 1

Variable Description

Variables	Variables Proxies	Data Sources
Carbon Emissions	Metric tons per capita	World Bank (WB)
Income Inequality	Quantiles (top 10%, middle 40%, bottom 50%)	World Inequality Database (WID)
Population Density	Per km square	World Bank (WB)
GDP	Gross Domestic Product per capita	World Bank (WB)
GDP^2	Gross Domestic Product square	World Bank (WB)
Urban Population	Annual percentage	World Bank (WB)

Table 1

Estimated results of Heteroscedasticity

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.318995	Prob. F(14,21)	0.2755
Obs*R-squared	16.84424	Prob. Chi-Square(14)	0.2646
Scaled explained SS	5.857165	Prob. Chi-Square(14)	0.9700

Table 3

Estimated results of Serial Correlation Breusch-Godfrey Serial Correlation LM Test

F-statistic	**Prob. F(2,19)**	**Obs*R-squared**	**Prob. Chi-Square(2)**
7.779075	0.0418	25.45541	0.0000

Table 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.
None *	0.773771	131.0636	125.6154	0.0223
At most 1	0.654828	80.53255	95.75366	0.3471
At most 2	0.437945	44.36629	69.81889	0.8504
At most 3	0.341147	24.77699	47.85613	0.9245
At most 4	0.175833	10.59031	29.79707	0.9702
At most 5	0.102218	4.015300	15.49471	0.9023
At most 6	0.010217	0.349161	3.841466	0.5546

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.
None *	0.773771	50.53105	46.23142	0.0163
At most 1	0.654828	36.16626	40.07757	0.1293
At most 2	0.437945	19.58930	33.87687	0.7844
At most 3	0.341147	14.18668	27.58434	0.8095
At most 4	0.175833	6.575008	21.13162	0.9686
At most 5	0.102218	3.666139	14.26460	0.8928
At most 6	0.010217	0.349161	3.841466	0.5546

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level