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FACTORS AFFECTING CO2 EMISSION: AN EMPIRICAL INVESTIGATION OF PAKISTAN'S ECONOMY

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Abstract

This empirical study investigates the factors that influence CO2 emissions in the context of Pakistan's economy. Pakistan, being one of the world's most populous and developing countries, presents tremendous problems in terms of environmental sustainability and climate change mitigation. This study aims to identify the primary drivers of CO2 emissions in Pakistan, providing light on the complex interplay between foreign direct investment (FDI), industrialization, urbanization, infrastructure development, power projects, and deforestation. The study utilizes regression to account for unobserved heterogeneity at the entity level and time-specific effects using autoregressive distributed lag model (ARDL) approaches. The study uses a dataset spanning 22 years (2001-2022), with an emphasis on period-specific fluctuations and trends. The findings of this study give important insights into the elements that contribute to CO2 emissions in Pakistan. Policymakers and stakeholders acquire a better knowledge of the drivers of environmental concerns in the region by determining which factors have significant connections with CO2 emissions and which are made inconsequential owing to collinearity. These findings may be used to support targeted policy initiatives in Pakistan aimed at reducing emissions, encouraging sustainable economic growth, and minimizing the negative consequences of climate change. This study adds to the body of knowledge on environmental economics and provides a foundation for evidence-based decision-making in the pursuit of a more sustainable and environmentally responsible future for Pakistan's economy in a global context marked by the imperative to address climate change and reduce greenhouse gas emissions.
Keywords: FDI, CO2 emissions, Sustainability, ARDL, MLR.

Introduction

Accurately predicting future global warming in response to a doubling of atmospheric carbon dioxide, or "climate sensitivity," is one of the major challenges of our time. The adverse impact of global warming can be a catastrophic threat for humanity existence. Developing countries are particularly vulnerable affected by climate change because the global economic situation has undergone unprecedented changes since the early 1990s (Claudio-Quiroga, Gil-Alana, & Maiza-Larrarte, 2023). All the markets has pose potential threat regarding opening, closing, expansion as well as biodiversity and economic development.

The climate of the world is changing gradually because of expansion in human activities on the earth such as foreign direct investment, industrialization, urbanization, transportation and infrastructure; in addition greenhouse effect increases, energy imbalance& deforestation (Lee, Zhou, Yang, Yu, & Zhao, 2023). Rainfall on Earth is redistributed, glaciers and permafrost melt, and the sea level rises as a result of global warming. This endangers not only the stability of natural ecosystems but also creates a threat to human life.In the recent decades, conservation efforts were measurable, but by 2050, the world's economy will have grown far too quickly and needlessly, posing a threat to human existence (Tan, 2021).

Nature has always been an important aspect of both society and individuals, thus there is an urgent need to safeguard the environment. The greatest method to conserve biodiversity is to reduce CO2 emissions (Yin, 1994). However, Flores, Flore-Lagunes, and Kapetenakis (2014) discharge of gasses such as carbon dioxide, methane and alike others due to human activities in daily life on the earth like burning fossil fuels, manufacturing in industries etc.

CO2 (Carbon Dioxide) Emissions

The degree to which economic activity destroy the environment are to inequality in distribution of income and power, limited access to clean the technologies and inadequate institutional framework for sustainable development (Poumanyvong & Kaneko, 2010). Foreign Direct Investment (FDI) is an amount of individuals, organizations that invested to improve the economic activity (Hussain & Hussain, 2017). FDI is a long lasting interest between cross boarder countries. FDIis associated with world development.

Foreign Direct Investment (FDI)

Foreign direct investment (FDI) may offer cash, technology, skills, and market access to host nations while also stimulating local investment, employment, and productivity (Degong, Ullah, Khattak, & Anwar, 2018). However, depending on the kind, industry, and location of the investment, FDI might have severe environmental consequences. FDI may raise carbon emissions by moving carbon-intensive industrial processes and technology from developed to developing nations, or by increasing carbon-intensive industries in host countries such as mining, manufacturing, and transportation.

Urbanization

Urbanization referred to the context of Modernization, which means that how many persons are lived in a society and the cities are growing, higher and the higher of the persons shifted from rural to urban areas (Zhu, Xia, Guo, & Peng, 2018). The movement of human (labor-intensive) society from rural to urban areas becomes the cause of increasing CO2 emission. Urbanization is frequently accompanied by a variety of socioeconomic developments, such as infrastructural development, economic concentration, and the modification of social and cultural dynamics (York, 2007). There is a major problem faced that a number of labor forces moves from rural to industrial areas for better opportunities in the last decades.

Industrialization

Industrialization is a collection of economic and social processes that work together to create value in a more efficient manner (Rehman, Hengyun, & Ozturk, 2021). Economic development is a challenge that will be accomplished through industrialization (Destek & Okumus, 2019). All kind of industries are the case to increase CO2 emission. A procedure of production and manufacturing is based on industries at commercial level such as steel industries, resource extracting industries and manufacturing industries. The economic development is based on primary sector economic growth of industries.

Infrastructure

Infrastructure is the physical look of a business, region, or nation, and includes transportation infrastructure, water supply infrastructure, a company's IT infrastructure, and so on. Road transport is a viable source of road infrastructure for emerging nations such as Pakistan, China, India and Malaysia etc. (Siddiqui & Pant, 2007). Road infrastructure facilitates the people to move easily in short time and transfers the goods & services but on contrary, it requires better transportation system, which will reduce CO2 emissions.

Deforestation

An also major factor of increasing CO2 emission is deforestation. Deforestation is the long-term or exceptionally long-lasting conversion of woodland to other land uses, for example, agriculture, field, water reservoirs, infrastructure, and urban areas (Garba, Tama, & Ammani, 2020). A wide variety of plant and animal species live in forests. Deforestation causes habitat damage, leading in biodiversity loss and the probable extinction of species.

Review Of The Literature

All nations and the international community were affected by the problem of global warming. The Intergovernmental Panel on Climate Change (IPCC, 2001) estimates that during the 20th century, Earth's surface warmed by about 0.6 C, which almost all scientists directly attribute to greenhouse gas (GHG) emissions, of which carbon dioxide (CO2) emissions account for 73% (Zhang, Liu, & Bae, 2017).

This study aims to achieve two goals: One is to estimate the limit of carbon dioxide (CO_2) emissions in Pakistan and the other is to investigate the effects of various factors on CO_2 emissions. These factors include FDI, Urbanization, Industrialization, Power Projects, Infrastructure and Deforestation. Firstly explore the relationship between FDI and CO_2 emission and then examine the impact of other development-related factors on CO_2 emissions.

The Environmental Kuznets Curve (EKC) model describes how economic growth affects economic structure changes. The Kuznets U-shaped curve shows that economic growth goes through three stages: from agriculture to industry, from industry to post-industry, and from post-industry to services. Environmental harm rises when the economy shifts from rural to urban and from farming to manufacturing as production and consumption increase. Then it declines when the economy moves from heavy industry based on energy to technology-based industries and services.

Foreign Direct Investment and CO2 Emissions

Globalization has transformed the world economy since the early 1990s, with market liberalization, trade expansion, and increased monetary flows, especially foreign direct investment (FDI). FDI has become a key driver of global economic growth. Many developing countries, such as Pakistan, have relied on their own resources and economic systems to benefit from FDI inflows. Pakistan is pursuing economic growth and stability through FDI. FDI contributes to income generation by enhancing the value of total output, as many studies and theories on economic growth have shown (Kinda, 2010).

FDIs have economic, political, and social impacts as they transfer technology, financial capital, and other skills. Moosa (2002) argues that the political impacts mainly concern the threat to national sovereignty, while the social impacts involve the potential cultural change of society. The economic impacts include various effects on output, balance of payments, and market structure. Choong and Lam (2010) agree that FDI enhances economic growth by providing capital, improving productivity, creating new jobs, and increasing competitiveness. However, some studies claim that FDI does not have a direct impact on economic growth (Carkovic & Levine, 2002; Durham, 2004).

The relationship between FDI and CO2 emissions has been mainly examined through two hypotheses in recent decades: the pollution haven hypothesis and the pollution halo hypothesis (Aminu, Clifton, & Mahe, 2023). FDI increases CO2emissions by relocating polluting industries to regions with less strict environmental regulations, while the latter implies that FDI reduces emissions by transferring clean technologies to the host countries (Ghazouani, 2021). Several studies have supported the pollution haven hypothesis, such as Omri, Nguyen, and Rault (2014), who found a positive impact of FDI inflows and a bidirectional relationship between other variables for a panel of 54 countries over 20 years.

Solarin, Al-Mulali, Gan, and Shahbaz (2018) and Liu et al. (2017) found that FDI only lowered CO2 emissions in developed countries. Shahbaz, Nasir, and Raubaud (2018) used the bootstrap ARDL model to test that FDI degraded the environment in France and found that FDI inflows reduced carbon emissions. Solarin et al. (2018) collected data from 80 developed and developing countries and found that FDI was a cause of CO2 emissions.

Urbanization and CO2 Emissions

Environmental degradation and pollution emissions are often linked to urbanization in the literature (Wang et al., 2016). Private and public transport, urban construction with cement and steel, and energy for household goods and services in urban areas are the main factors that cause this harmful effect (Zhang & Lin, 2012). The Lewis-Fei-Ranis theory suggests that push and pull forces influence population movement from rural to urban areas (Lewis, 1954). Economic development and industrial expansion push people away from rural areas and pull them towards urban areas.

A high level of urbanization and economic growth depends largely on FDI as an important driver (Muhammad, Long, Salman, & Dauda, 2020). FDI can have both positive and negative effects on urbanization and its environmental impact. On the one hand, FDI can boost capital accumulation and attract more people to urban areas where labor demand is high. On the other hand, FDI can bring in cleaner technologies or environmental awareness that enhances emission efficiency in the urbanization process. These effects may reinforce or counteract each other, depending on the amount of foreign capital involved. Therefore, the net effect of urbanization on emissions may differ across different levels of FDI (Lee, Zhou, Yang, Yu, & Zhao, 2022).

The effect of urbanization and income inequality on CO_2 emission in BRICS countries (Brazil, Russia, India, China and South Africa) from 1994 to 2013 was using panel quantile regression to account for individual and distributional heterogeneity (Zhu, Xia, Guo, & Peng, 2018). They found that urbanization had a significant and negative effect on CO_2 emission. Alam, Fatima, and Butt (2007) used a time-series data model similar to STIRPAT to study the impact of urbanization and CO_2 emission in Pakistan and found a positive relationship between them. Parikh and Shukla (1995) argued that urbanization increased per capita energy consumption and hence CO_2 emission. Shahbaz, Chaudhary, and Ozturk (2017) and McGranahan, Jacobi, Songsore, Surjadi, and Kjellen (2001) reported a positive relationship between urbanization and CO_2 emission.

Zhang, Yu, and Chen (2017) discovered a U-shaped relationship between the variables, meaning that CO2 emissions increased in the early stage of urbanization and decreased after reaching a certain level of urbanization. York (2007) found a negative relationship between urbanization and CO_2 emission in developing countries using OLS regression, but this result turned positive later. Zhu, You, and Zeng (2012) examined the non-linear relationship between urbanization and carbon dioxide gas in 20 emerging countries over 16 years using a fixed effect model.

Industrialization and CO2 Emissions

Global warming and climate change are among the most contentious and difficult issues those countries around the world face. This study adds to the recent literature on the effect of industrialization on CO2 emissions (Rehman, Hengyun, & Ozturk, 2021). Al-Mulali and Ozturk (2015) reviewed all the factors that affected the environment and found that industrialization was one of the main sources of increasing pollution.

Rafique, Li, Larik, and Monaheng (2020) used the Augmented Mean Group (AMG) method to examine the relationship betweeninnovation in industrialization, FDI, financial development, and carbon emissions in the BRICS from 1990 to 2017 and found that innovation significantly reduced carbon emissions. Omri and Bel-Hadj (2020) applied the Generalized Method of Moments (GMM) approach from 1996 to 2014 and found a similar result. Fei, Rasiah, and Shen (2014) used an autoregressive distributed lag model and found that innovation can help lower carbon emissions.

Kemal (2006) described that the growth rate of industrialization in Pakistan are more than doubled from 2003-2018. Manufacturing has expanded at rates of 14.1 and 12.5 percent over the past two years, with large-scale manufacturing expanding at even faster rates of 18.2 and 15.4 percent (Kemal, 2006). It is impossible to disregard the role that cities play in reducing CO2 emissions; second, the city serves as the primary hub for both production and consumption, making it the primary contributor to CO2 reduction (Zhu, Liu, Tian, Wang, & Zhang, 2017).

According to United Nations (2015), urban population increased rapidly, 17.4% in 2015 is projected to be increased 76% by 2050. The urban population increases but rural population steadily decreasing. To fulfil the requirement of population's necessity of life needed more industries for production and manufacturing. To cover up the demand of urban population are the basic infrastructure like building, transportation and supporting facilities.

Power Project and CO_2 Emission

In Pakistan, the factors that affect economic growth need to be explored. There is still room for improvement in the economy due to unreliable power supply, inconsistency, misinformation about electricity consumption, and electricity scarcity; all these factors hinder economic development and consumer welfare (Qudrat-Ullah, 2022). Ikegami and Wang (2016) examined that there are two types of energy produced; one for consumer use and the other for national defense. Energy projects also emit harmful pollutants that damage the environment. Therefore, we should have accurate data on electricity projects, available infrastructure, and potential challenges for long-term purposes.

Pakistan, a developing country with increasing energy demand and a persistent power crisis, also signed the PA in 2016. As stated by Pakistan's 2016 Intended Nationally Determined Contribution (INDC), it will face higher energy demand due to population and economic growth and aim to reduce emissions by 5% from 2012 levels by 2030 (Gao et al., 2019). Pakistan's electricity sector is the main source of CO_2 emissions (that is, 46% of total emissions of 342 Mt CO_2 in 2012. Pakistan's electricity sector will contribute about 67-64 Mt CO_2 in 2030. Pakistan's major sources of environmental emissions can reduce emissions through alternative measures (Akimoto et al., 2010).

Energy is an input for output. Mekonnen, Gerbens-Leenes, and Hoekstra (2015) examined that there are two methods to produce energy, one is using fossil fuels that cause global warming and the other is using water resources for energy production. Mekonnen et al. (2015) introduced the concept of water footprint and CO_2 emission footprint from power generation; an important energy policy of distribution of water footprint and CO_2 emission footprint related to power generation. Malik, Hussain, Baig, and Khokhar (2020) studied that CO_2 emission is very critical for Pakistan, as it is one of the top victims of climate changes. From 1970 to 2015, total energy CO_2 emission was 174843 kt, a growth of 820%; this will increase up to 226790 kt by 2030, a growth of 27%.

A Univariate Model, Autoregressive Moving Average Model (ARIMA) was used to predict the CO_2 emission for Pakistan. The forecast results clearly showed that Pakistan failed to meet the National Determined Contributions Pledge at COP21 (Khan, Yaseen, & Ali, 2017). In other scenarios, if Pakistan adopts the mitigatory strategies to curb the emissions, then total CO_2 emission would be less than 10%.Renewable energy can help reduce CO2 emissions effectively. Compared to conventional energy, renewable energy is safe, clean, and unlimited in supply (Khan, Yaseen, & Ali, 2017).

Infrastructure and CO_2 Emission

Road infrastructure produces a lot of greenhouse gas (GHG) throughout its life cycle, which includes making raw materials, building, operating, maintaining, and restoring the roads (Aryan, Dikshit, & Shinde, 2023; Santero & Horvath, 2009). In recent decades, global economic and population growth have led to a huge expansion of the road networks, especially in developing countries (Fan & Chan-Kang, 2005). By 2050, more than 25 million kilometers of new roads are expected to be built, which means a 60% increase from the 2010 level (Shi, Yang, Zhang, Chapman, & Fan, 2003). About 90% of all new roads will be built in developing countries.

According to a World Bank study, the transport sector is responsible for almost 14% of global CO2 emissions and about 72% of that was caused by road construction, restoration, maintenance, and usage (The World Bank, 2011). The large-scale road construction causes massive CO2 emissions. In the U.S., building, maintaining, and restoring highways account for around 28% of CO2 emissions from the transport sector (Joseph & Mustaffa, 2023) and 13.22% from the construction sector (Anega & Alemu, 2023). In European countries, road construction is one of the main drivers of resource use (Xu, Xie, Xia, Ji, & Huang, 2021) and contributes a lot to global warming (Aryan et al., 2023).

As the report showed, Asia is responsible for about 37% of total CO2 emissions, with China accounting for almost 19% of the world's total or more than 50% of Asia's contribution (The World Bank, 2011). The extensive road networks in developing countries such as Pakistan, India &China caused a continuous increase of CO2 emissions (Aryan et al., 2023). A typical technique for systematically assessing the environmental effects of goods, processes, or service systems throughout the course of their life cycle is life-cycle assessment (LCA) (Oyeyi, Achebe, Ni, & Tighe, 2023). The LCA approach was frequently employed to calculate the CO2 emissions related to the transportation infrastructure (Aryan et al., 2023).

In order to investigate the effects of in-place recycling practices on pavement construction and repair, from Portugal used the LCA model (Flower & Sanjayan, 2016). In-place recycling-based building has been shown to lower CO2 emissions by 75% when compared to conventional construction. In the UK, Wang (2023) created an

LCA model that considered recycling practices for the building and maintenance of asphalt-paved roads. Their research concluded that rather than aggregates, greater focus should be placed on programsfor recovering asphalt surfaces (Wang, 2023).

Deforestation and CO_2 Emission

For the past 20 years, Pakistan's economy has experienced great growth in its forest region; nevertheless, unanticipated climate change has ruined it. Rising temperatures throughout time, several floods long-lasting droughts and the emergence of new pests and diseases had a significant impact between 2010 and 2014 (Rehman, Ozturk, & Zhang, 2019). The loss of forests due to climate change is noteworthy. National food security was endangered by production and solemn. Infrastructure was being seriously damaged by uncontrollable changes in climatic scenarios that affect the lives of all stakeholders in the agricultural sector.

To address the detrimental consequences of climate change on the agricultural sector, numerous new cutting-edge technical breakthroughs are being developed (Yahya & Lee, 2023). With its impacts on global climate change, including habitat destruction and glacier melt on the tops of mountains, CO2 emission in the environment poses a serious danger to sustainable growth. The temperature will increase once again, causing droughts and floods. Pakistan, a developing nation, did not experience these climatic shifts, therefore this study will add to the body of knowledge on CO2emissions.

The impact of CO2 emissions and deterioration in the USA was discussed by Pablo-Romero, Sánchez-Brazaaand Gil-Pérez (2023), studied the connection between deforestation and CO2emissions in Pakistan, resulting asymmetric effect of CO2emissions on agriculture and deforestation. Wood logging and fire are both used in the Brazilian Amazon to degrade the forest, which has a negative impact on biodiversity, the structure of the forest, carbon stores, and other factors (Barlow & Peres, 2008).

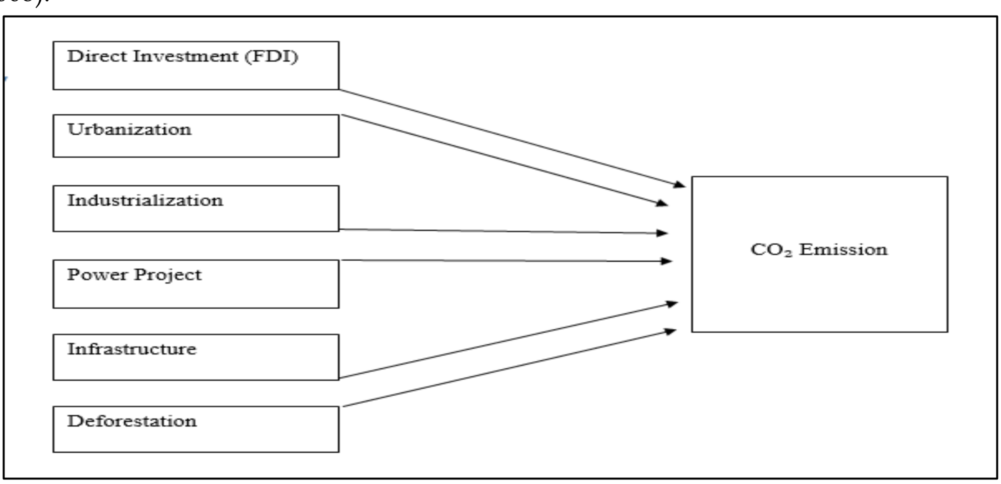

Figure: Theoretical Framework

Table 1: Summary of recent Literature on FDI, Urbanization, Industrialization, Power Project, Infrastructure and Deforestation on CO2 Emissions

Study	Sample & Period	Techniques	Major Finding (s)
Aminu, Clifton, and Mahe (2023)	13 Sub-Sahara African Countries (1995-2019)	Ordinary Least Square Technique (OLS)	It identified a long-term relationship between finance, economy and CO2 emissions, by 2.5 times.
Ghazouani (2021)	Tunisia (1980-2016)	Autoregressive Distributed Lag Model (ARDL), Vector Error Correction (VEC) Model	The results conclude that CO2 emissions, FDI, Urbanization, Industrialization, technologies and economic growth are cointegrated in long-term linkage.
Liu, Wahab, Hussain, Sun and Kirikkaleli (2021)	China (1995-2017)	Advanced Panel Methods	FDI and GDP positively affected Carbon emissions and Technology, Renewable Energy Resources & Foreign Trade inversely affected on carbon emissions.
Solarin, Al-Mulali, Gan and Shahbaz (2018)	80 Develop and Developing Countries	Generalized Method of Moments (GMM)	FDI, GDP per capita, Urbanization and Biomass consumption per capita have positive effect on CO2 emissions.
Omri, Nguyen, and Rault (2014)	54 Countries (Europe and Central Asia, Latin America	Dynamic Simultaneous-Equation Panel Data Models	FDI and CO2 emissions are interact and effected the economic growth of Middle East,

	and the Caribbean, and the Middle East, North Africa, and sub-Saharan Africa)(1990-2011)		North Africa, and sub-Saharan as well as have abidirectional causality in Europe and Central Asia, Latin America and the Caribbean.
Choong and Lam (2010)	Malasiya (1970-2006)	VectorAutoregressive (VAR) Model and Vector Error Correction Model (VECM)	FDI have a positive effect on economic growth and significant impact on carbon emissions.
Carkovic and Levine (2002)	Minneapolis, Saint Paul (1960-2002)	Ordinary Least Square Model (OLS)	FDI directly & indirectly effected on the growth of schooling, govt. projects, private sectors and it affected on environmental hazards.
Lee, Zhou, Yang, Yu, and Zhao (2022)	China(1996-2018)	STIRPAT Model	Urbanization initially increases CO2 emissions & harmful after a certain level it becomes weaker.
Muhammad, Long, Salman, and Dauda(2020	Brazil, Russia & India (2000-2016)	2-StagesLeastSquare Regression,Panel Quantile Regression	FDI increased CO2 emissions, Import increased CO2 emissions in low-income countries.
Zhu, Xia, Guo, and Peng (2018)	BRICS Countries (1994-2013)	Heterogeneity and Distributional Heterogeneity, Panel Quantile Regression	Urbanization has a significant and negative impact on carbon emissions
Wang et al. (2016)	BRICS Countries	Heterogeneous Panel Cointegration Test	Long run relationship exists

	(1985-2014)		in urbanization and CO2 emissions.
Zhang and Lin (2012)	China (1995-2010)	STIRPAT Model, Pane Data	Results showed thaturbanization increases energy consumption and carbon emission in China.
Aslam, Fatima, and Butt (20017)	Pakistan (1971-2005)	Unit Root with ADF Test	Urbanization growth, population growth, energy growth are impacted on environmental degradation.
Parikh and Shukla (1995)	Pakistan (1965-1987)	Fixed Effect Model	Moreurbanization uses maximum energy becomes the cause of global warming.
Shahbaz, Chaudhary, and Ozturk (2017)	Pakistan (1972-2011)	STIRPAT Model,ARDL Bound Test, VECM Granger Causality Approach	Economic growth increases energy demand and Technology has a positive impact on energy consumption andgreatly effected on CO2 emissions.
Zhang, Yu, and Chen (2001)	141 Countries (OECD and Non-OECD) (1961-2011)	STIRPAT Model, Two Way fixed Effect Model	Population in urban areas of the large cities have a significantly effect on CO2 emissions.
Zhu, You, and Zheng (2012)	20 Emerging Countries (1992-2008)	Semi-Parametric Panel Data Model, Panel Data with Fixed Effect	Urbanization andCO2 emissionsare statistically significant.

Rehman, Hengyun, and Ozturk (2021)	Pakistan (1971-2019)	Unit Root Test, Quantile Regression Analysis	Industrialization, Energy Importation and Economic Progress has positively exposed on CO2 emissions.
Al-Mulali and Ozturk (2015)	14 MENA Countries (1996-2012)	Panel Unit Root Tests, Pedroni Cointegration Test	Energy Consumption, Urbanization, Trade Openness, Industrial Output increases environmental damage.
Rafique, Li, Larik, and Monaheng (2020)	BRICS Countries (1990-2017)	Augmented Mean Group (AMG)	BRICS countries possess a negative and statically significant long run association ofindustrialization with CO2 emissions.
Omri and Hadj (2020)	23 Emerging Countries (1996-2014)	Generalized Method of Moments (GMM) approach	FDI,Industrialization and Technology has positive influence on carbon emissions in the host countries.
Zhu, Liu, Tian,Wang, and Zhang (2017)	China (1997-2012)	Input-Output Analysis	Industrialization strongly increase CO2 emissions.
Ikegami and Wang (2016)	Japan and Germany (1996-2015)	Granger Causality Test, ARDL Regression Model	Significant cointegration relationshipin betweenpower consumption, GDP andcarbon emissions.

Yousuf, Ghumma, Hashmi, and Kamal (2014)	EU Countries (2005-2020)	DNE 21+ Model Bottom Up Modeling (200-300 specific technologies are modeled)	Power projects are significantly influenced on CO2 emissions.
Malik, Hussain, Baig, and Khokhar (2020)	Pakistan (2017-2020)	Autoregressive Integrated Moving Average (ARIMA)	All the data set under different scenarios CO2 emissions gradually increased since 1970.
Khan, Yaseen, and Ali (2017)	34 Upper Middle Income Countries from Asia, Europe, Africa and America (2001-2014)	Generalized Method of Moments (GMM), Ordinary Least Square Model (OLS), ANOVA, Panel Unit Root Tests	Financial development, Tradingand Energy Consumption highly effected on CO2 emissions.
Aryan, Dikshit, and Shinde (2023)	Total 67 Studies (80 on Developed Countries + 20 Developing Countries) (1996-2021)	Granger Causality Test, ARDL Regression Model	Road infrastructure including pavement effected on CO2 emissions.
Fanand Chan-Kong (2005)	Chna (1984-2003)	Book Reference	Road infrastructure economically strong the national but it also has a negative influence on environmental hazards and degradation.
Joseph and Mustaffa (2023)	China, Europe& USA	PRISMA, Life Cycle Assessment (LCA)	Strategies are established to uniform the

	(2015-2019)		standard equipment, low carbon design, policies & regulations will potentially carbon emissions reduced.
Xu, Xie, Xia, Ji, and Huang (2021)	China (2002-2017)	Single-RegionalInput-Output (SRIO), Tapio Decoupling Analysis (TDA), Structural Decomposition Analysis (SDA)	Electricity production sector and construction sector are the largest direct and embodied carbon emissions source.
Anega and Alemu (2023)	Ethiopia (1971-2009)	Quanltile Regression, Fixed and Random Effect Model	Rural road and access to Real road raises the per capita carbon emissions and real consumptions of per capita.
Oyeyi, Achebe, Ni, and Tighe (2023)	Canada	Life Cycle Assessment	Construction environment impact is increase.
Rehman, Ozturk, and Zhang (2019)	Pakistan (1998-2017)	Autoregressive Distributive Lag (ARDL) Bound Test	Long run evidence reveals that cropped area, energy consumptions, fertilizer offtake, GDP per capita, water availability have a positive and significant association with CO2 emissions.
Pablo-Romero Gil-Delgado, Sánchez-	19 Latin American Countries (1991-2014)	Applied Regression, Panel Data, Generalized Method Of Moments Quantile-Regression	More forestation are showing positive growth of economy, in contrast

Braza, and Gil- Pérez (2023)		deforestation create increased more CO2 emissions.

RESEARCH METHODOLOGY

Our study is being investigated using research methods. This section describes the study methodology, demographic, and sample size in depth. A research technique is an architectural design that is used to find, solve, and explore new information that is widely acceptable. This study will assist policymakers in developing CO2 emission policies.

Research Approach

To get the required outcomes, a quantitative technique used (Yin, 1994). Burns and Grove (2010) employ the quantitative technique to demonstrate the hypothesis/theory and show the challenges. For modern study, a quantitative method used to examine the link between Chinese FDI, urbanization, industrialization, power projects, infrastructure, and deforestation and CO2emissions in Pakistan.

The quantitative technique employed to build the connection situation and profitability based on the facts. Furthermore, research objectives classified into three types, with the ultimate aims being informative, descriptive, and exploratory research. This study is classed as a valuable exploration, as can be seen from these categories, because the thought process of exploration is to uncover and clarify the link between China's FDI and other developmental factors.

Population

Many nations throughout the world have conducted research to determine the origin of CO2 emissions, however in Pakistan, a developing country; no research on CO2 emissions was conducted to explain the cause of growing global warming.

Sample Size

To determine the impact of Chinese FDI, urbanization, industrialization, power projects, infrastructure, and deforestation on CO2emissions in Pakistan from 2003 to 2022.

Data Type and Source

Secondary data employed in this investigation. This analysis, which spans the years 2003 through 2022, relied on annual data from Pakistan. Data on Chinese FDI gathered from the State Bank of Pakistan and the World Bank. World Development Indicators provided data on urbanization, industrialization, power projects, infrastructure, and deforestation (WDI, 2018). The purpose of this study is to investigate the link between urbanization, carbon emissions, FDI inflows, and innovation, as well as the incorporation of industrialization and real GDP into Pakistan's carbon emission models. GDP growth thought to increase CO2 emissions, and a linear link was proposed. Existing theoretical efforts, on the other hand, are made in three ways to address the impact of urbanization on emissions.

Modernization Theory (MT),
Environmental Theory (ET)

City Theory (CT) are the three theories (Poumanyvong & Kaneko, 2010).

Changes in social development exacerbate environmental harm since Modernization Theory (MT) posits a link between national urbanization and CO2emissions, and societies often continue to prioritize income levels over environmental safety. I believe there is a chance of success. However, in order to promote environmental sustainability (Sadorsky, 2014), these nations' significance will alter once they achieve a critical level of growth and have a consistent income. Environmental Theory (ET) is centered on income levels, whereas MT ties urbanization to CO2emissions at the city level (Miao, 2017).Higher urban affluence as a consequence of higher revenue from the expansion of manufacturing bases will lead to increased demand for energy, transportation, heating, and building, resulting in pollution. City Theory (CT) highlights the importance of urban style in achieving sustainable urbanization. Sustainable urban design encourages urban mobility by providing easy public transportation, which decreases reliance on private automobiles, traffic congestion, and gas emissions.

Model

Linear regression is a statistical procedure that calculates the value of a dependent variable using the value of an independent variable. Linear regression is used to investigate the relationship between two variables. It is a method of modeling that predicts a dependent variable based on one or more independent variables. Linear regression used to test the linearity, non-linearity, and lack of auto-correlation among variables (values).

Descriptive statistics used in data collecting to provide basic information about variables as well as to highlight potential relationships between variables.

A correlation matrix is a table that illustrates the correlation coefficients between variables. Each cell in the table shows the interaction of two factors.

According to the model, the error components have no autocorrelation with one another. There should be no heteroscedasticity in the data. Simply expressed, the variance and mean should be constant across the model. The data should be dispersed normally. The ARDL model used to predict and distinguish long-run connections from short-run dynamics. Relationship across time: even if the individual time series fluctuate a lot, equilibrium forces link certain time series together. However, some variables were stationary at the level, while others were stationary at the first difference, which is why the ADF test was used to make the data stationary at the second difference because there was no stationary at the first difference.

In the early 2000s, Pesaran, Shin, and Smith (2001) developed the autoregressive distributed lag (ARDL) bounds test to deal with models including time series with mixed or unknown orders of integration. This approach is widely used because it has several advantages over other cointegration testing methods. However, many researchers employ this test in circumstances that contradict the underlying assumptions of the testing methodology.

According to the aforementioned theoretical backdrop and the subsequent Shahbaz et al. (2018), among the dynamic econometric models, the Auto-regressive Lag Model (ARDL) used to examine the influence of the above-mentioned explanatory factors on CO2emissions using time series data spanning 2003-2022.

Results And Conclusion

Based on the Poumanyvong and Kaneko (2010) model, the fundamental framework for carbon dioxide emissions constructed in order to explore the relationship between the dependent variable and the independent variable.

CO2t = f (FDI t, URB t, IND t, PP t, INFST t, DFRST t)

Where:

CO2 Carbon Dioxide Emissions (metric ton per capita)

FDI Foreign Direct Investment (net inflows, % of GDP)

URB Urbanization (percentage of total population)

IND Industrialization {(including construction), value added (% of GDP)

INFST Infrastructure {road transportation, (percentage of total fuel combustion)}

PP Renewable Energy Consumption (percentage of total final energy consumption)

DFRST Deforestation (percentage & of total forest)

t Residual Term

The Auto-regressive Lag Model (ARDL), which used to examine the effects of the aforementioned explanatory factors on CO2 emission using time series data from 2003 to 2022, was implemented in accordance with the theoretical background discussed above.

Table 2: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
CO2 Emission	0	.801	.072	684	.956
FDI	0	2.143	1.429	.383	4.488
Urbanization	0	38.767	.928	36.18	39.997
Industrialization	0	3457.86	265.968	2991.771	4143.338
Infrastructure	0	29.688	1.148	28.103	31.743
Power Projects	0	46.783	2.516	42.09	51.54
Deforestation	0	8.507	.705	7.101	9.798

These statistics depict the variables' features. CO2 Emission is an outcome variable that was impacted by predictors such as FDI, urbanization, industrialization, power projects, and infrastructure. The factors were measured during a 20 years period (2001 to 2020). The central measure of tendency is the mean (average). It indicates the variable's average value over the 20 observations. The mean for the variable "CO2 Emission," is 0.801. The standard deviation measures how dispersed. It shows how far the data deviates from the mean. Greater variability is indicated by a higher standard deviation. The standard deviation for the variable "CO2 Emission," is about 0.072, indicating that there is little variation around the mean. For each variable, this is the least value discovered in the dataset. It represents the tiniest data point. For "CO2 Emission," the minimum value is roughly 0.684. For each variable, this is the maximum value discovered in the dataset. It is the most important piece of information. The maximum value for "CO2 Emission," is around 0.956. With a CO2 emission of 0.801 metric tons per capita. The values range from around 0.684 to almost 0.956, with a relatively low standard deviation of about 0.072 and an average FDI of about 2.143. FDI values range from about 0.383 to about 4.488, with a standard deviation of around 1.429 and an average urbanization rate of 38.767%. The rate of urbanization ranges from around 36.18% to almost 39.997%, with a very low standard deviation of approximately 0.928. With a mean level of industrialization of around 3457.86. Industrialization levels range from around 2991.771 to approximately 4143.338, with a standard deviation of approximately 265.968 and a mean infrastructure score of approximately 29.688. Infrastructure ratings vary from around 28.103 to about 31.743, with a standard deviation of about 1.148 and an average renewable energy use of 46.783. Renewable energy consumption figures range from about 42.09 to approximately 51.54, with a standard deviation of around 2.516 and an annual deforestation rate of approximately 8.507. Annual deforestation rates range from around 7.101 to about 9.798, with a standard deviation of about 0.705.

Table 3: Pair wise Correlation

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CO2Emission	1.000						
FDI	0.526	.000					
Urbanization	0.650	0.572	.000				
Industrialization	0.474	0.574	0.528	000			
Infrastructure	0.198	0.127	0.171	0.095	000		
Renewable Energy	0.976	0.514	0.688	0.433	0.220	.000	
Annual Deforestation	0.131	0.147	0.371	0.088	0.108	.109	.000

Pair wise correlation, also known as pairwise correlation coefficient or pairwise correlation analysis, is a statistical approach that was used to determine the degree and direction of a linear relationship between two variables in a dataset. It computes a correlation coefficient for each pair of variables, indicating how strongly they are connected. The Pearson correlation coefficient (r) is the most often used correlation coefficient in pairwise correlation analysis.

The diagonal cells (from top-left to bottom-right) carry each variable's correlation coefficient with itself, which is always equal to 1. This is an example of a variable's perfect correlation with itself.

The correlation coefficients between distinct pairs of variables are contained in the upper triangular area of the matrix (above the diagonal).

The correlation coefficients in the bottom triangular component of the matrix (below the diagonal) are mirrored from the top part.

A correlation coefficient of 1 (1.000) indicates that it has a complete positive correlation with itself. It had a positive association with FDI (0.526), Urbanization (0.650), and Industrialization (0.474), implying that when CO2 emissions rise, so do these factors, albeit the degree of the link varies. It related to CO2 emissions (0.526), urbanization (0.572), and industrialization (0.574) in a favorable way. It correlates positively with CO2 emissions (0.650), FDI (0.572), and industrialization (0.528).It has a positive relationship with CO2 emissions (0.474), foreign direct investment (0.574), and urbanization (0.528).Correlations with other factors are weaker and usually positive, but not very strong. There is, for example, a positive association with FDI (0.127). It has a significant negative correlation with CO2 emissions (0.976), meaning that as renewable energy usage grows, so do CO2 emissions.Correlations with other factors are diverse, but the magnitudes are small. For example, there is a 0.131 connection with CO2 Emission.These correlation coefficients reveal information about the connections between variables. Positive numbers indicate that there is a positive linear relationship, whilst negative values indicate that there is a negative linear relationship. The magnitude of the correlation coefficient reflects the intensity of the association, with values closer to 1 suggesting a greater link (positive or negative).

Table 4: Stationarity Analysis

Variable	ADF at Level		ADF at Second Difference	
	t-Statistics	p Value	t-Statistics	p Value
(1) CO2 Emission	-1.931	0.3175	-3.187	0.0207
(2) FDI	-2.437	0.1316	-2.819	0.0577
(3) Urbanization	-3.710	0.0040	-3.666	0.0046
(4) Industrialization	-2.243	0.1911	-2.691	0.0756
(5) Infrastructure	-2.995	0.0354	-2.643	0.0844

(6) Renewable Energy	-2.133	0.2315	-2.645	0.0840
(7) Annual Deforestation	-2.769	0.0628	-2.578	0.0976

The null hypothesis (H0) in the context of the ADF test is that the time series data is non-stationary, which implies it has a unit root. The alternative hypothesis (H1) is that the data is stationary, which means that it lacks a unit root.

At Level:

t-Statistics This is the test statistic calculated by the ADF test. It measures how many standard deviations the sample mean is away from the hypothesized mean under the null hypothesis.

p Value This is the probability associated with the test statistic. It tells you the likelihood of obtaining the observed test statistic under the null hypothesis.

If the p-value is less than a chosen significance level (commonly 0.1, 0.05 or 0.01), you would typically reject the null hypothesis and conclude that the data is stationary. For "Urbanization," the p-value at the original level is 0.0040, which is less than 0.05. Therefore, you would conclude that the "Urbanization" variable is stationary at the original level.At the initial level of "CO2 Emission," the p-value is 0.3175, which is larger than 0.05. As a result, you would not reject the null hypothesis, implying that the variable "CO2 Emission" may be non-stationary at the initial level.

AT Second Difference:

The "ADF at Second Difference" result is identical to the "ADF at Level," but it applies to time series data after a second difference (differencing the data twice). Non-stationary data is frequently made stationary via second differencing. Similarly, the p-value for the second difference might be interpreted. After taking the second difference, you would infer that the data is stationary if it is smaller than your specified significance threshold.After accounting for the second difference, the p-value for "Urbanization" is 0.0046, which is less than 0.05. After accounting for the second difference, you would infer that "Urbanization" is stationary.After accounting for the second difference, the p-value for "CO2 Emission" is 0.0207, which is likewise less than 0.05. After taking the second difference, you would infer that "CO2 Emission" is stationary.In summary, the ADF test findings indicate that after taking the second difference, "Urbanization" and "CO2 Emission" become stationary, while "CO2 Emission" stays non-stationary at the original level. When modeling time series data, stationarity is a crucial concern, and the results of these tests assist establish the right treatment for the data in your research.

Table 5: Results of Auto Regressive Distributive Lag (ARDL) Model

ARDL(2,2,0,2,0,2,0)Regression

Sample: 2003 – 2020

Number of Jobs.=18

F (14, 3) = 14.83

Prob> F = 0.0237

R-squared	=	0.9858
Adj R-squared	=	0.9193
Log likelihood	=	62.874501
Root MSE	=	0.0180

CO2 Emission	Coef.	Std.Err.	t	P>t	[95%Conf.	Ival]
CO2 Emission						
L1.					-	
	0.725	0.574	1.260	0.296	1.101	2.552
L2.					-	
	-0.761	0.096	-7.927	0.071	1.422	1.099
Foreign Direct Investment						
					-	
	-0.009	0.008	-1.050	0.370	0.035	0.017
L1.					-	
	0.004	0.008	0.550	0.619	0.020	0.028
L2.					-	
	0.006	0.006	10.00	0.041	0.014	0.027
Urbanization					-	
	0.035	0.016	2.188	0.085	0.046	0.053
Industrialization						
			-		-	-
	-14.169	0.173	81.760	0.768	16.371	11.967
L1.						
	17.538	0.114	154.210	0.425	16.093	18.983
L2.			-		-	
	-7.690	0.179	43.050	0.052	9.960	-5.420
Infrastructure					-	
	0.706	0.008	88.25	0.054	0.020	0.032
Renewable Energy						
					-	
	-0.034	0.005	-6.670	0.007	0.051	-0.018
L1.					-	
	0.021	0.021	1.030	0.380	0.045	0.088
L2.					-	
	-0.897	0.027	-33.22	0.085	0.045	0.044

Deforestation						-	
	-0.910	0.023	-39.56	0.048	0.052		0.031
_cons						-	
	0.698	1.922	0.360	0.074	5.417		6.814

Analysis of Autoregressive Distributed Lag (ARDL) regression using lag orders of (2, 2, 0, 2, 0, 2, 0). ARDL is an econometric modeling approach for estimating relationships between variables in a time series setting.

The lag orders for the variables in the ARDL model are specified here. The numbers represent the lag durations for various factors. For example, "2" denotes a 2-period lag for certain variables, whereas "0" denotes no delays for others. Sample data was 2003 - 2020: This shows the period during which the analysis was carried out, which ranges from 2003 to 2020.Number of observations = 18: This informs you how many observations are in your dataset, which is 18 in this case. F (14, 3) = 14.83: This is the overall model's F-statistic. It assesses the model's overall relevance. The F-statistic in this situation is 14.83.The p-value associated with the F-statistic is Prob> F = 0.0237. It examines the null hypothesis, which states that all of the coefficients in the model are jointly equal to zero. A low p-value (usually 0.05) indicates that the model is statistically significant.R-squared = 0.9858: The R-squared (R2) value indicates how well the model explains variance in the dependent variable. The model explains roughly 98.58% of the variation in the dependent variable in this situation.R-squared adjustment = 0.9193: The adjusted R-squared is a variant of R-squared that accounts for the number of predictors in the model. When adding more variables to the model, it is frequently used to assess the quality of fit. It is 91.93% here.Log likelihood = 62.874501: This is the model's log likelihood value. It was employed in the selection and comparison of likelihood-based models.Root MSE = 0.0180: The root mean squared error (RMSE) is a measure of the prediction error of the model. The average difference between expected and observed values is quantified. The RMSE in this situation is roughly 0.0180. Emissions of CO2: At delays L1 and L2, the coefficient estimates for lagged CO2 emissions was reported. The statistical importance of these lag terms was shown by the t-values and p-values.FDI (Foreign Direct Investment): FDI coefficients, like CO2 emissions, are evaluated at lags L1 and L2. The t-values and p-values indicate the importance of the data.Annual Deforestation, Urbanization, Industrialization, Infrastructure, &Renewable Energy: These variables were connected with coefficient estimates, standard errors, t-values, and p-values. These values aid in determining the importance and influence of each variable on the model's dependent variable._cons: This reflects the model's constant term or intercept. The coefficient estimate, standard error, t-value, and p-value are all included. Overall, this ARDL table gives a thorough overview of the model's statistics as well as the predicted coefficients for each variable, allowing you to analyze the relevance and correlations between the variables in the context of the chosen lag orders.

Robustness Analysis

This study used (Multiple Linear Regression) (MLR) methodology to accomplish the robustness analysis. MLR yielded the following results:

Table 6: Results of Multiple Linear Regression (MLR)

CO2Emissions	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
CO2 Emission	0.069	0.032	2.16	.069	0.005	0.127	
FDI	1.521	0.421	3.61	005	0.587	2.436	**
Urbanization	0.068	0.027	2.52	.081	0.017	0.079	
Industrialization	0.089	0.029	3.07	.099	0.772	0.711	
Infrastructure	0.079	0.039	20.3	.084	0.131	0.062	
Renewable Energy	0.018	.005	3.60	.017	-.019	.004	*
Constant	2.566	.396	6.48	0	1.711	3.422	**

Mean dependent var	0.801	SDdependent var	0.072
R-squared	0.963	Number of obs	20
F-test	54.505	Prob> F	0.000
Akaike crit. (AIC)	101.561	Bayesian crit. (BIC)	-94.590

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

MultipleLinear Regression is a statistical approach that is use to examine the connection between a dependent variable ("CO2 Emission") and numerous independent variables such as FDI, urbanization, industrialization, infrastructure, and renewable energy. This analysis used to determine how well the independent factors explain the variance in the dependent variable collectively.

The calculated coefficients for each independent variable represented the change in the dependent variable for a one-unit change in the related independent variable, while all other variables remain constant. The standard errors of the coefficient estimations are represented by these numbers. They assess the accuracy of the coefficient estimations. The t-value is the coefficient estimate to standard error ratio. It calculates how many standard deviations the coefficient has from zero. Larger t-values suggest that the coefficients are statistically significant.The p-value reflects the likelihood of finding a t-value as severe as the one estimated if the real population coefficient was zero. Smaller p-values indicate more evidence against the null hypothesis of the coefficient being zero. The coefficient for FDI is 1.521, which indicates that a one-unit increase in FDI connected with an estimated 1.521 unit increase in CO2 emissions. At the 0.01 level, the coefficient is statistically significant (***), indicating a strong association. The Renewable Energy coefficient is 0.018, suggesting that a one-unit increase in Renewable Energy is related with an estimated increase in CO2 emissions of 0.018 units. At the 0.05 level, it is statistically significant (**).Urbanization and infrastructure are similarly favorable, but their p-values are slightly higher than 0.05. They are marked as significant (*) at the 0.1 level.The Industrialization coefficient is positive, although it has a p-value greater than 0.1, suggesting that it is not statistically significant at conventional levels. The F-test examines the model's overall significance. A low p-value (p 0.001) indicates that at least one independent variable is strongly connected to the dependent variable. The p-value associated with the F-test is Prob> F. The total model is statistically significant if the value is modest (p 0.05). The Akaike criterion (AIC) and the Bayesian criterion (BIC) are model selection criteria that were use to compare alternative models. Lower values represent a better match. In conclusion, this regression analysis examines the link between CO2 emissions and a number of independent factors. It appears that FDI and Renewable Energy are statistically significant predictors of CO2 emissions. However, industrialization does not appear to be a major predictor in our model.

Conclusion And Policy Recommendations

It viewed as a game changer for Pakistan's faltering economy since it predicted to boost economic growth to 7.5 percent between 2015 and 2030 (Mirza et al., 2019). Pakistan's atmosphere is also changing because of rising CO2 emissions. Since the industrial revolution, humans have produced a significant quantity of CO2 emissions. Global warming has intensified because of increased human activity, and this has had a significant influence on the ecosystem. Expansion of metropolitan areas resulted in higher energy use, which influenced CO2 emissions. According to the study, every 1% rise in urbanization results in a 0.2 percent increase in CO2 emissions.

Modern advances have been developed in industries and other economic domains, but the disproportionate increase in CO2 emissions has also had an impact on environmental quality. When industrialization accelerates, natural resources taken more quickly, affecting the overall well-being of the big population. Industrialization expansion would be a source of pollution (industrial waste, gasses, energy usage, etc.) and contribute to increasing CO2 emissions. The study's goal is to investigate the influence of CO2 emissions on infrastructure development. The reason for increased urbanization is improved infrastructure; also, industrialization growth is dependent on infrastructure since it provides secure transit for commodities. All human activities rely on automobiles, which contribute to rising CO2 emissions.

More roads mean more traffic, which means more CO2 emissions. The increase in urbanization and manufacturing necessitates increased energy usage. The creation of energy is a large consumer, and the EU is quickly recognizing it as one of the most important variables influencing human health, economic prosperity, and national security. Power plants are required to meet the needs of urbanization and industry. Power plants also emitted hazardous toxic gasses that harmed the environment.

According to the ARDL model, the variables CO2 Emission, Foreign Direct Investment (FDI), Urbanization, Infrastructure, Renewable Energy, and Deforestation all have statistically significant coefficients in explaining CO_2 emissions. While relevant in some delays, industrialization may not be a strong predictor. To properly comprehend the links between these factors and CO_2 emissions, more investigation and interpretation are required.

According to the multiple linear regression model, FDI, Urbanization, Infrastructure, and Renewable Energy all show substantial positive associations with CO_2 emissions. The p-values indicate that the coefficients of these variables are statistically significant at varying degrees of significance. Industrialization shows a favorable association as well, although it is statistically insignificant ($p = 0.099$). The constant (intercept) is statistically significant, suggesting that it influences model fit. The model accounts for 96.3% of the variation in CO_2 emissions, and the F-test validates the model's overall statistical significance.

With a coefficient of 1.521 and a p-value of 0.005, FDI exhibits a statistically significant positive link with CO_2 emissions (***). This implies that a one-unit increase in FDI is related with a 1.521-unit rise in CO_2 emissions on average.

With a coefficient of 0.068 and a p-value of 0.081 (*), urbanization likewise has a statistically significant positive link with CO_2 emissions. This suggests that greater urbanization connected with increased CO_2 emissions.

The association between industrialization and CO_2 emissions is positive, but statistically significant ($p = 0.099$). The value of the coefficient is 0.089.

Infrastructure has a 0.079 coefficient of correlation with CO_2 emissions. However, although being positive, the coefficient is not statistically significant at conventional levels ($p = 0.084$).

With a coefficient of 0.018 and a p-value of 0.017 (**), renewable energy has a statistically significant positive connection with CO_2 emissions. This suggests that growing use of renewable energy is connected with increased CO_2 emissions.

The model's constant term has a statistically significant coefficient of 2.566 and a p-value of 0 (***). This constant indicates the regression line's intercept.

An R-squared (R^2) score of 0.963 indicates that the model has a high level of explanatory power. The model's independent variables explain about 96.3% of the variance in CO_2 emissions.

The whole model is statistically significant, according to the F-test (F-statistic = 54.505, p 0.001). This implies that at least one of the independent variables has a substantial relationship with CO_2 emissions.

For model comparison, model selection methods such as the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) were utilized. Lower AIC and BIC values imply a better fit of the model.

Suggestion

The Pakistani government's "National Climate Change Policy" and "Environmental Assessment Cell" should be involved and given special focus to reducing CO_2 emissions.

Pakistan must encourage renewable and clean energy initiatives that are both environmentally beneficial and cost effective.

Planting more trees is the simplest and cheapest strategy to cut CO2 emissions and address environmental concerns. The KPK government has launched a campaign to plant a 10 billion-tree tsunami, and this type of initiative should be applicable to all other provinces with approved special budgets for plants and plantation land.

Strict and appropriate legislation should be enacted to protect forests and wildlife and to restrain the wood mafia.

Enacted legislation governing vehicle maintenance and upgrades, as well as the use of alternative fuels.

Future Recommendations

Implementing a Cap and Trade system can be a successful legislative strategy for reducing greenhouse gas emissions, promoting environmental sustainability, and encouraging industry to move to cleaner, more sustainable methods.

It is critical to develop a flexible strategy adapted to various sectors in order to meet unique problems and opportunities while encouraging innovation and sustainability within those industries.

Significant financial help from rich countries is required to aid poor countries in their attempts to mitigate climate change, adjust to its effects, and achieve sustainable development goals.

Establishing a strong technology transfer program is critical to facilitating the cross-border spread of innovative solutions and information, allowing developing nations to leapfrog and accelerate their path to sustainable development.

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