IMPACT OF ENERGY CONSUMPTION, URBANIZATION, FDI AND ECONOMIC GROWTH ON CO_2 EMISSION IN PAKISTAN

By

SABA BIBI

Department of Economics

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SABA BIBI

SUPERVISOR:

DR.AYAZ AHMED

Department of Economics

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CERTIFICATE

This is to certify that this thesis entitled: **"Impact of Energy Consumption, Urbanization, FDI and Economic Growth on Co_2 Emission in Pakistan"** submitted by Ms. Saba Bibi is accepted in its present form by the Department of Economics, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree of **Master of Economics**.

External Examiner:

Dr. Faiz Ur Rehman
Assistant Professor
Quaid-i-Azam University
Islamabad

Supervisor:

Dr. Ayaz Ahmed
Senior Research Economists
PIDE, Islamabad

Head, Department of Economics:

Dr. Karim Khan
Associate Professor/Head
Department of Economics
PIDE, Islamabad.

Author's Declaration

I SABA BIBI hereby state that my MSC thesis titled IMPACT OF ENERGY CONSUMPTION, URBANIZATION, FDI AND ECONOMIC GROWTH ON CO_2 EMISSION is my own work and has not been submitted previously by me for taking any degree from PIDE or anywhere else in the country/world. At any time if my statement is found to be incorrect even after my Graduation the university has the right to withdraw my MSC degree.

Date:_____ SABA BIBI

Dedicated to

My loving parents

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Abstract:

This study aims to provide better and comprehensive understanding of how energy consumption, urbanization. FDI and economic growth impact on CO_2 emission. By applying time series data in case of Pakistan, analysis has been done over the period of 1973-2017. ARDL co-integration and granger causality is employed to examine the relationship and causality among energy consumption, urbanization, FDI economic growth and CO_2 emission. Based on earlier studies, main indicators that have impact on CO_2 emission are energy consumption, urbanization, FDI and economic growth. The overall analysis suggests that relationship between energy consumption, urbanization. FDI economic growth and CO_2 emission is positive and statistically significant. This infers that GDP growth, urbanization, FDI and energy consumption are key factors of CO_2 production. The result of Granger causality shows that there is two-directional causality among CO_2 emission and economic growth similarly among FDI and CO_2 emission which demonstrate that economic actions FDI influx are key causes of global pollutant CO_2 emission. Correspondingly, there is one-directional causality as of energy consumption headed for CO_2 emission, depicts that energy is leading cause in CO_2 production.

Table of Content

List of Tables

List of Figures

CHAPTER 1
INTRODUCTION

1.1 Background

Living in a clean and healthy environment is desirable as well as need for economic growth of any country because environment provides resources to the economy and absorbs emissions and extra waste. Environment provides natural resources for production in many sectors which in turn may cause pollution and degradation. Carbon emission is one of the leading factors contributing towards climate change and bringing serious consequences for environment by altering water supplies, weather pattern, and changes in growing season for cultivation etc. due to this reason nowadays environment has become the main concern of all advanced and developing countries. So the researchers and policy makers are investigating the main aspects of environmental degradation.

In literature it is widely accepted that GDP growth, FDI, trade openness, transport and energy usage are the leading factors causing greenhouse gases (CO_2 emission). Climate changes and global warming has adverse impact on human beings, animals and plants life. Therefore, all countries pay much attention towards climate changes and trying to reduce CO_2 emission to save human beings and beauty of environment. In economic literature „Environment Kuznets Curve" has been used to examine the inverted U-shape correlation between GDP per capita and ecological deprivation (Kankesu & Verma, 2011; Chandran & Tang, 2013; Dogan & Turkeku, 2015; Saidi & Ben, 2016).

Although, Pakistan is not a country with a high level of CO_2 emissions, but a country with a high rating which is most affected by global warming. However, CO_2 emissions have been increasing day by day because Pakistan's main objective is to achieve high economic growth and development for which high energy consumption and FDI is required. As Pakistan is in transition phase of development and its main thrust is economic growth in manufacturing sector which demands low-priced input resources. At any stage of manufacturing and production energy is considered as main input and use of cheap and non-renewable energy resources cause high CO_2 emission. Besides energy operation, there are number of factors that can cause CO_2 emission.

Figure 1.1: Factors Causing CO_2 Emission

A different chain of research focused on dynamic relationship amongst energy demand, GDP growth and CO_2 release. Khsobai & Roux (2017) observed two-direction causality among energy use and GDP growth and one-direction causality from CO_2 emission to energy demand and GDP growth in South Africa. Similarly, Aslan *et.al* (2013) observed feedback hypothesis among consumption of energy and GDP growth in USA. Omri (2013) analyze CO_2 emission, energy demand and GDP growth in MENA countries and deduce one-direction causality from energy consumption toward CO_2 production and feedback causality among GDP growth and CO_2 release.

The process of urbanization refers to re-distribution of population from countryside areas to urban centers, natural urban population growth and reclassification of cities. Urbanization is one of major dynamic of economic activities as the fact that cities are base camp for agglomerated market and often known as “engine of growth” in a country. Pakistan is also fronting rapid development of urbanization which has numerous impacts on energy demand and CO_2 emission. The fact that this process contribute to economic growth of country also requires high energy consumption in terms of utilization of crude oil, electricity, natural, gas and coal which ultimately produce CO_2 emission in environment.

1.1 Objective of Study

The existing study attempted to examine the impact and causal correlation among CO_2 emission, FDI, urbanization, energy consumption, and economic growth. We do not find an extensive literature regarding causal relationship among CO_2 emission, FDI, urbanization,

energy consumption, and GDP growth in case of Pakistan. The objectives of the study are as follow:

- Explore the effect of FDI, GDP growth, urbanization, energy consumption on CO_2 emission.
- Analyze the long run and short run co-integration among FDI, growth in economy, urbanization, energy consumption and CO_2 emission.
- Explore causality among FDI, GDP growth, urbanization, use of energy and CO_2 emission.

1.2 Statement of Problem

In past few decades, environmental degradation and CO_2 emission was not the major problem but, with the advances such as industrial revolution, increases population, trade openness, urbanization, FDI etc. this issue has become a major concern for all developed and developing countries. CO_2 emission has now become a global problem which attracts the human attention due to its severe long-run consequences. In literature many studies have been conducted which shows different results according to given data, focused variables and countries.

In literature different determinants of CO_2 have been discussed such as FDI, trade openness, urbanization, energy consumption, population etc. In many countries researchers have analyzed the main determinants and causes of CO_2 but in case of Pakistan no much attention is being paid towards this major issue. The major concern of many developing countries like Pakistan is to enhance economic growth by more urbanization, increase energy consumption or by bringing more FDI but there are no strict environmental policies. This attracts foreign investor to produce at low cost and use dirty and cheap method of production which emits high amount of CO_2 resulting in low environment quality. Similarly urban development and urban population demand more energy and transport energy consumption cause environmental risk.

The research related to CO_2 emission and its main determinant does not exist as intensive as in other countries of the world. So, in present study we will study the impact of FDI, urbanization, energy usage, and economic growth CO_2 emission and will also explore the causal correlation among these indicators in case of Pakistan over the period 1971-2017.

1.3 Hypotheses

The study tests the following hypotheses;

i. There have not been any significant changes in the trends of CO_2 emission in Pakistan.
ii. FDI, economic growth, urbanization, energy consumption do not have any significant effect on CO_2 emission in Pakistan.
iii. No long-run and short-run association of FDI, GDP growth, urbanization, and energy consumption with CO_2 emission.
iv. There will be no causality among FDI, GDP growth, urbanization, energy consumption and CO_2 emission.

1.4 Significance of the Study

Today environmental threat is matter of subject for both developing and developed countries because it contributes towards long run sustainable development. Therefore, the goal sustainable development is not only to achieve high growth rates but also takes into account the environmental risk.

CO_2 emission cause many serious issues in environment which affect our plants, animals and human life like global warming, Ocean Acidification, Desertification. It is also foundation of biological changes, changes in food supply, increasing instance of severe weather and lessening water supplies. This study provides relationship and factors which are foremost cause of CO2 emission that ultimately helps to gauge inferences and impact of these variables on environment conditions.

1.5 Organization of the Study

The remaining sections are sequenced as: Chapter 2 provides the comprehensive overview of the obtainable literature. Chapter 3 clarifies about theoretical framework and data descriptive analysis. Chapter 4 provides estimation methodology for our study. Chapter 5 argues the observed results and Chapter 6 summarizes the conclusion and policy recommendation

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter we discuss in detail the existing literature of different determinants which may affect quality of environment and contribute in CO_2 emission. For sustainable development growth it‟s very crucial to control CO_2 emission and environment hazards. Most researcher studied the association among energy consumption and CO_2 emission, correspondingly some researchers consider economic growth as main determinants of increasing energy demand which eventually produce CO_2 global pollutant. However increasing FDI, urbanization and trade openness get attention by some researchers in last two decades in developing and developed co countries. This chapter has three sections. The first section is detailed study on other countries, second describes the review in case of Pakistan and third is conclusion drawn from all reviewed studies.

2.2 Empirical Literature:

Halicioglu (2008) explored the influence of energy consumption, income and trade openness on CO_2 emissions in Turkey from period between 1960-2005 by applying bound co-integration test and augmented granger causality technique. Author found two form of long run relationship, first is that energy utilization, GDP per capita and FDI is chief factor in CO_2 radiation emission and second is that income is affected by means CO_2 radiation emission, energy consumption and FDI. Among all variables GDP per capita is significant determinant in explaining the increase in CO_2 global pollutant. FDI, commercial energy consumption and income significantly and noticeable influenced the emission of CO_2 globally environment pollutant in study of turkey.

Acharyya (2009) studied the effect of FDI, GDP growth on environment in India during the time period 1980-2003.Author empirically examine long run effect of foreign trade openness on economic development, and the long run effect of FDI influx on CO_2 emission and biohazard. CO_2 radiation is one of main global pollutant which contaminates the environment. Author quantifies the indirect influence of trade on CO_2 emission via boost in economic activities. Finding show that high coefficient of FDI-led growth elasticity of CO_2 which demonstrates that FDI is one of main factor in producing CO_2 emission. Study concluded that dirty industries are chief consumer of energy sector and producer of CO_2 emission.

Chandran & Tang (2013) examined the effects of transport energy usage, FDI and GDP per capita on CO_2 emissions in five Asian economies using co-integration and granger causality techniques. The long-term elasticity estimation results demonstrate that the influence of GDP per capita and transport energy consumption on CO_2 footprints is statistically positive and

significant. Deduced result describes two-way causality among transport energy consumption, trade openness and CO_2 emission in Thailand and Malaysia.

Alper *et al*.(2013) assessed the correlation between consumption of energy and GDP growth (evidence from micro data) by taking data from 1997-2009 for 47 US states. Authors used granger causality, Pedroni (1999) panel co-integration techniques to study the relationship among variables. Authors observed one-way directional causality from energy utilization to real GDP. Feedback hypothesis observed among consumption of energy and economic growth in case of these 47 states. The interdependency of variables confirms that negative shock in energy supply would lead negative influence on real GDP.

Omri (2013) by employing the Cobb –Douglas production function, investigate the interrelationship among CO_2 emissions, energy consumption and GDP growth nexus in MEENA countries through simultaneous equation model over the time period from 1990 to 2011 Result concluded the two-directional causality among energy consumption and GDP growth due to which assumption of neo classical discarded which specified that energy is neutral for economic growth (because increasing economic activities need more energy use) and one- directional causality from energy consumption towards emission of CO_2 global pollutant . However, bidirectional causality is observed among economic growth and CO_2 radiation which point toward that persistent increase in environmental degradation would cause negative waves on economy by effecting human beings, animals and plants life.

Linh & Lin (2014) examined association among energy consumption, GDP growth and FDI on CO_2 emissions in Vietnam during period 1980-2010 to study the Environmental Kuznets Curve by employing co-integration and Granger Causality test. Estimated e result display the EKC theory does not hold in case of Vietnam. CO-efficient of co-integration results demonstrates FDI flux as essential factor to generate economic activities and thus high income attract capital from foreign countries. Granger causality observed two-directional causality among trade openness and energy consumption likewise among energy consumption and environmental pollution. Provided results show that FDI boost industrialization therefore demand for energy consumption increases which consequently contribute in CO_2 emission, correspondingly pollution heaven hypothesis hold in Vietnam.

Hossain & Hasanuzzaman (2014) studied the effect of energy use, urbanization, financial growth, and foreign trade on the atmosphere in Bangladesh by using an ARDL bound test methodology for period between 1975-2010.Authors estimated that energy consumption and growth of cities are core bases of CO_2 emission in Bangladesh. Given result depicts negative trend among increasing GDP per capita and CO_2 emission .Conversely no causal relationship observed among international trade, financial development and carbon emission.

Omri *et al.* (2014) considered causality between CO_2 emissions, FDI, and GDP growth by employing dynamic simultaneous-equation models for 54 countries for the duration of the of

1990-2011.Findings demonstrate that FDI inflow have positive and significant impact to breed economic activities through capital financing that influence GDP per capita through productivity expansions and technology revolution which consequently lead to environmental deterioration. Authors concluded two main findings from their data results; one is that there is two-directional causality among FDI influx and GDP growth likewise among FDI inflow and CO_2 contaminant, the secondly that there is one-directional causality from CO_2 emission to GDP growth.

Leitao (2014) explored the outcome of GDP growth, renewable energy and Globalization on CO_2 emissions by using OLS, GMM and VEC model for time period 1970-2010 in Portuguese country .Results depict that Globalization and renewable energy utilization are positive and highly significant co-related with economic improvement. By using OLS method positive correlation detected among energy consumption and GDP growth same result observed by means of GMM technique. Nevertheless by using VEC methodology negative relationship showed among energy consumption and real GDP growth which convince policy maker to shift toward the use of clean energy.

Shahbaz *et al.* (2015) empirically searched the outcome of urbanization on CO_2 emissions in Malaysia over duration of 1970-2011. By using Bayer Hanck co-integration approach and VECM Granger causality study analyze that major factor in CO_2 emission is economic growth. For economic growth capital stock is needed and more capital stock increases the energy demand. Findings show that intensification in trade growth boost energy consumption, and positive relation is observed among urbanization and CO_2 emission. Authors project the expansion of urbanization and industrial sector impact on environmental degradation followed the Kuznets theory. Economic transformation by government of Malaysia leads to greater demand of energy consumption.

Linh & Lin (2015) investigated dynamic and fundamental interactions between CO_2 emissions, energy use, GDP growth and FDI in the 12 populated Asian countries from year 1980-2010.Authors used granger causality to check the long-term and short-term relationship surrounded by variables. The result shows the relationship among income and environment deterioration followed EKC theory. Authors comprehend that CO_2 emission is income –inelastic, whereas CO_2 emission is elastic in the event of energy utilization. Bi-directional short run association among GDP per capita and FDI, among CO_2 emission and energy utilization. The relationship examined among FDI and income suggest that high income attract FDI flux which sequentially boost national income.

Dogan & Turkekul (2016) studied the outcome of real output, energy-demand, trade, urbanization and financial growth on CO_2 emissions .For testing the EKC hypothesis in USA for time period 1960-2010 by using ARDL bound co-integration test. Statistics results show that in long-term energy utilization and urbanization have significant impact on CO_2 emission that causes environmental hazards, while financial development is insignificant to stimulate

environmental deterioration. By using the result of this study USA government should device such energy policies that boost GDP but not at the expense of environmental degradation.

Saidi & Mbarek (2016) studied the effect of GDP per capita, trade openness, urbanization, and financial advancement on CO_2 emissions in 19 developing economies over the period 1990-2013. By using GMM technique authors estimate their equation of model. Findings demonstrate negative and significant correlation of financial growth and carbon emission, conversely positive relationship has been observed among income growth and CO_2 emission. Urbanization is statically insignificant to influence the CO_2 emission and environmental conditions in case of these countries.

Zhu *et al.* (2016) conduct a study on the impacts of FDI, economic development and energy consumption on CO_2 emissions in ASEAN-5 countries over the period from 1980-2011 by using quintile regression method. The empirical result show that influence of different variables on carbon emission varies in quantiles. In lower quintile FDI is positive but insignificantly influence CO_2 emission , due to which pollution heaven hypothesis does not hold in case of lower income countries . Regardless, FDI negatively influence CO_2 emission in case of middle and high-income countries that confirms halo-effect hypothesis hold in these countries. However, co-efficient of GDP growth shows negative and significant impact on CO_2 global pollutant in case of high income countries quintiles that shows CO_2 emission can alleviate environmental depletion through high economic growth which confirms EKC theory holds in high income countries. Similarly, the population size is positive co-integrated with CO_2 emission in lower income counties quintile and negatively related in case of high income countries quintile

Ali *et al.* (2016) explore dynamic outcome of urbanization, growth of economy, energy utilization, and trade liberalization on CO_2 emissions in Nigeria for period 1971-2011. By using ARDL co-integration insignificant impact of urbanization on CO_2 emission has been observed in Nigeria. International trade is negative co-integrated with CO_2 emission; however, high GDP growth and more energy demand are positive co-integrated with CO_2 emission. Empirical results determine that countries with high urbanization and low GDP per capita do not have significant impact CO_2 emission. Results deduced that there would be reduction in CO_2 emissions by introducing strict environmental policies.

Mert & Boluk (2016) observed the effect of FDI and renewable energy-usage on CO_2 emissions in case of 21 Kyoto countries by employing panel ARDL approach from year 2002-2010. Result support pollution halos hypothesis due to which demonstrate that FDI inflow lead to improve environment quality. Empirical findings show that EKC theory does not hold both in long-term and short-term which determines that there is no inverted u-shaped relationship have been observed among GDP per capita and CO_2 emission in these countries. Authors explored statically that high economic growth develops economic activities which lead to high energy demand (fossil fuels) and capital influx that subsequently produce more CO_2 in environment. On the other hand use of renewable resources is negatively related to environmental degradation.

Khobai (2017) investigated the association among energy demand, GDP growth and CO_2 emission in South Africa for the period between 1971-2013.The studies investigated the equation of model by employing Johansen co-integration technique to show the long run association among variables. Also by applying granger causality two-directional causality has been observed between energy utilization and economic activities. By using VECM technique deduced result demonstrates energy led growth hypothesis in South Africa. The other finding observed one-directional causality from CO_2 emission, FDI and urbanization towards GDP growth and energy demand.

Behera (2017) analyzed the outcome of urbanization, energy demand, and FDI on the CO_2 emission in the South and Southeast Asian region over the period from 1980 to 2012 by classifying countries into different groups according to income level. By using Pedroni co-integration showed that urbanization, energy utilization, trade openness and CO_2 emission are co-integrated in all counties irrespective of their income level. In Auxiliary regression the energy-demand for fossil fuel is used instead of primary energy consumption, in this case long-term and short-term co-integration has been observed among FDI, urbanization, CO_2 emission and fossil fuel consumption in middle income countries. Westerlund co-integration illustrate that energy consumption highly co-integrated with CO_2 global pollutant in middle income and low income countries which consequently deteriorate environment, but no long run relationship observed in high income countries because of their standard regulatory policies implications.

Wang *et al. (*2018) explore the effect of urbanization, GDP growth, energy utilization on CO_2 emissions by taking empirical indication from diverse income level countries from time period of 1980–2011 by using granger causality test , Pedroni co-integration test and VAR model to forecast. Findings show that there in long-term and short-term two-directional causality among GDP growth and urbanization, CO_2 radiation and urbanization, energy utilization and GDP growth, CO_2 emission and economic growth. Estimated result deduce that influence of economic development on climate changes fluctuates according to development stages and income level of countries

Sakiru & Usama (2018) studied the influence of FDI on indicators of environmental filth for 20 countries over the period of1982-2013.The study quantify result by applying Westerlund co-integration test , CCEMG estimator and augmented mean group estimators. Result showed positive relationship of Real GDP and energy use on environmental deterioration but this relationship is less significant in case of developed countries paralleled to emerging countries result. Similarly when relationship among urbanization and environmental degradation attested, negative relationship observed in developed countries and positive in emerging countries. However, FDI has negative impact on environment quality in advanced countries while positive in low industrialization countries.

2.3 Empirical literature in Pakistan:

Raza *et al*. (2015) studied the energy management policies and trade growth in Pakistan to scrutinize the feedback hypothesis from time period 1973-2013. Feedback hypothesis hold because of empirical result indicates two-directional causality between GDP growth and energy consumption. However empirical result show positive effect of trade and GDP growth on energy demand. Estimation results display the positive correlation between energy consumption and international trade similarly results display bidirectional causality among trade and energy demand.

Hamid (2016) studied the FDI as chief source of environmental deterioration in Pakistan by using ARDL approach of co-integration over the period 1972 to 2014.Findings show that both in short run and long run FDI has positive and significant impact on CO_2 emission. Empirical result show bi-directional causality among FDI and CO_2 emission by using Granger causality. Empirical outcomes determine positive and significant impact of GDP growth on CO_2 emission, conversely negative and insignificant effect of energy consumption on CO_2 emission has been observed.

Danish *et al*.(2018) demonstrating the effect of transportation energy consumption on CO_2 emission in Pakistan by applying ARDL and VECM method from 1990-2015.Authors observed transport energy utilization significantly and positively influences the CO_2 emission, similarly FDI positively influences CO_2 emission due to which it is concluded that FDI and transport energy are foremost bases to create environmental degradation. But intensification in urbanization and economic activities not proved statically significant in production of CO_2 emission.

Ahmed (2016) studied the determinants of the CO_2 emission by using EKC theory in Pakistan from period of 1971 to 2008 by employing ARDL bound test method .Study examined the influence of energy consumption, GDP growth, trade liberalization and growing population on CO_2 emission. Findings confirms that EKC hypothesis not holds in short run however long run relationship have been observed among energy demand, trade liberalization, and economic growth and CO_2 emission. Empirical outcome shows that increasing population is also one of chief factor in production of CO_2 emission.

Table 2.1: Summary of Literature Review

S.NO	Authors	Title	Study Area	Conclusion
1	Acharyya (2009)	The effect of FDI, GDP growth on environment evidence from India.	The time period 1980-2003 by using co-integration approach.	Long run effect of foreign trade and FDI influx on CO_2 emission and biohazard. Author quantifies the indirect influence FDI on CO_2 emission via boost in economic activities.
2	Chandran & Tang (2013)	Effects of transport energy usage, FDI and GDP per capita on CO_2 emissions in five Asian economies	For time period 1980-2010 using co-integration & granger causality techniques.	Effect of GDP per capita and transport energy consumption on CO_2 footprints is statistically positive and significant. Deduced two-directional causality among transport energy consumption, trade openness and CO_2 emission.
3	Alper *et al*.(2013)	Co-integration between energy consumption and GDP growth (evidence from micro data) for 47 US states.	By taking data from 1997-2009. By using granger causality, Pedroni co-integration test.	Results show one-way directional causality from energy utilization to real GDP. Feedback hypothesis observed among energy consumption and economic growth in case of these 47 states.
4	Omri (2013)	Relationship among CO_2 emissions, energy consumption and GDP growth nexus in MEENA countries.	Through simultaneous equation model over the time period from 1990 to 2011	Result concluded the bidirectional causality among energy consumption and GDP growth & one-directional causality from energy consumption towards emission of CO_2 global pollutant.
5	Linh & Lin (2014)	Association among energy consumption, GDP growth and FDI on CO_2 emissions in Vietnam	During period 1980-2010 to study by using co-integration and granger causality test	Observed two-directional causality among trade openness and energy consumption likewise among energy consumption and environmental pollution. Pollution heaven hypothesis hold in Vietnam.

6	Hossain & Hasanuzzaman (2014)	The effect of energy use, urbanization, financial growth, and foreign trade on the atmosphere in Bangladesh	By using an ARDL bound test methodology for period between 1975-2010	No causal relationship observed among international trade, financial development and carbon emission. Energy consumption and growth of cities are core bases of CO_2 emission in Bangladesh.
7	Omri *et al.* (2014)	Causal relationship among CO_2 emissions, FDI, and GDP growth for 54 countries	For the duration of the of 1990-2011	Results show two-directional causality among FDI influx and GDP growth likewise among FDI inflow and CO_2 contaminant, secondly that there is one-directional causality from CO_2 emission to GDP growth.
8	Leitao (2014)	The impact of GDP growth, renewable energy and Globalization on CO_2 emissions in Portuguese country.	By using OLS, GMM and VECM model for time period 1970-2010.	Results depict that Globalization and renewable energy utilization are positive and significant co-related with economic growth. By using OLS and GMM method positive correlation detected among energy consumption and GDP growth.
9	Shahbaz *et al.* (2015)	The impact of urbanization on CO_2 emissions in Malaysia.	Over period of 1970-2011. By using Bayer Hanck co-integration approach and VECM Granger causality	Findings show that intensification in trade growth boost energy consumption, and positive relation is observed among urbanization and CO_2 emission. Authors project the urbanization and industrialization impact on environmental degradation followed the Kuznets theory.
10	Linh & Lin (2015)	Interactions between CO_2 emissions, energy use, GDP growth and FDI in the 12 populated Asian countries.	From year 1980-2010. Granger causality and co-integration used to check the long-run & short-run dynamics.	Results show that CO_2 emission is income –inelastic and energy consumption-elastic. Bi-directional short run association among GDP per capita and FDI, among CO_2 emission and energy utilization.

11	Dogan & Turkekul (2016)	The impact of real output, energy-demand, trade, urbanization and financial growth on CO_2 emissions in USA.	For time period 1960-2010 by using ARDL bound co-integration test	Statistics results show that in long-term energy utilization and urbanization have significant impact on CO_2 emission, while financial development is insignificant to stimulate environmental deterioration.
12	Saidi & Mbarek (2016)	Effect of GDP per capita, trade openness, urbanization, and financial advancement on CO_2 emissions in 19 developing economies	Over the period 1990-2013. By using GMM technique.	Findings demonstrate negative and significant association of financial growth and carbon emission, conversely positive relationship has been observed among income growth and CO_2 emission.
13	Zhu *et al.* (2016)	The impacts of FDI, economic development and energy consumption on CO_2 emissions in ASEAN-5 countries	Over the period from 1980-2011 by using quintile regression method.	In lower quintile FDI is positive but insignificantly influence CO_2 emission however FDI negatively influence CO_2 emission in case of middle and high-income countries. Co-efficient of GDP growth shows negative and significant impact on CO_2 global pollutant in case of high income countries quintiles .
14	Ali *et al.* (2016)	dynamic outcome of urbanization, growth of economy, energy utilization, and trade liberalization on CO_2 emissions in Nigeria	For period 1971-2011 by using ARDL co-integration	International trade is negative co-integrated with CO_2 emission; however, high GDP growth and energy demand are positive co-integrated with CO_2 emission.
15	Mert & Boluk (2016)	The effect of FDI and renewable energy-usage on CO_2 emissions in case of 21 Kyoto countries	By employing panel ARDL approach from year 2002-2010.	Result support pollution halos hypothesis which demonstrate that FDI lead to improve environment quality. Use of renewable resources is negatively related to CO_2 emission.s

16	Khobai (2017)	The relationship among energy demand, GDP growth and CO_2 emission in South Africa	For the period between 1971-2013 by using Johansen co-integration and granger causality	Two-directional causality has been observed between energy utilization and economic activities. Result demonstrates energy led growth hypothesis in South Africa
17	Behera (2017)	The effect of urbanization, energy demand, and FDI on the CO_2 emission in the SSEA region	Over the period from 1980 to 2012. By using Pedroni co-integration	Urbanization, energy utilization, trade openness and CO_2 emission are co-integrated in all counties irrespective of their income level. Westerlund co-integration illustrate that energy consumption highly co-integrated with CO_2 global pollutant only in middle income and low income countries
18	Wang *et al.* *(*2018)	The effect of urbanization, GDP growth, energy utilization on CO_2 emissions	From time period of 1980–2011 by using granger causality test , Pedroni co-integration test and VAR model	Findings show that there in long run and short run two-directional causality among GDP growth and urbanization, CO_2 radiation and urbanization, energy utilization and GDP growth, CO_2 emission and economic growth.
19	Sakiru & Usama (2018)	The effect of FDI on environmental pollution for 20 countries.	over the period of 1982-2013 by applying Westerlund co-integration test	Result showed positive relationship of Real GDP and energy use on environmental deterioration but this relationship is less significant in case of developed countries paralleled to emerging countries result
20	Raza *et al*. (2015)	the energy conservation policies and trade growth in Pakistan	To scrutinize the feedback hypothesis from time period 1973-2013	Feedback hypothesis hold because of empirical result indicates two-directional causality among GDP growth and energy consumption. empirical result show positive effect of trade on GDP growth &energy use.

21	Hamid (2016)	FDI as source of environmental deterioration in Pakistan	By using ARDL approach of co-integration and granger causality over the period 1972 to 2014	Findings show that both in short run and long run FDI has positive and significant impact on CO_2 emission. Empirical result show bi-directional causality among FDI and CO_2 emission.
22	Danish *et al*.(2018)	The effect of transportation energy consumption on CO_2 emission in Pakistan	By applying ARDL and VECM method from 1990-2015	Authors observed transport energy utilization have significant and positive influences on the CO_2 emission, similarly FDI positively influences CO_2 emission due to which it is concluded that FDI and transport energy are foremost bases to create environmental degradation
23	Ahmed (2016)	Determinants of the CO_2 emission by using EKC theory in Pakistan	from period of 1971 to 2008 by using ARDL bound test.	Findings do not support the EKC hypothesis in short run however long run relationship have been observed among energy demand, trade liberalization, and economic growth and CO_2 emission

2.4 Conclusion

The review of literature shows impact of the financial growth, urbanization, energy consumption, FDI, trade liberalization and economic growth on CO_2 emissions at an international level. Among all the aforementioned variables, short-term and long-term relationships and causality have been observed. In the context of Pakistan, there is a great empirical study dedicated for studying the effect of energy consumption, GDP growth, FDI, financial growth on CO_2 emission using time series data. But the effect of urbanization on energy consumption and CO_2 emission is still limited in literature. This study adds to the literature by examining the impact of GDP growth, growing urbanization, more energy utilization, FDI influx on CO_2 emission.

CHAPTER 3

THEORTICAL FRAMEWORK AND

DATA DESCRIPTIVE ANALYSIS

3.1 Introduction

In our study we are interested in examining the theoretical framework, empirical, graphical and statistical relationship between CO_2 emission and other predictor variables. This chapter contains two main sections; first covers theoretical framework and second covers collection of data, statistical, descriptive and graphical analysis. In our analysis we have used time series data set for Pakistan.

3.2 Theoretical Framework

Emission of carbon dioxide (CO_2) gas is one of the main factors contributing towards environmental pollution. CO_2 is the most significant greenhouse gas in the atmosphere. Its concentration in the atmosphere is increasing because rate of emission of CO_2 in more as compared to rate of its absorption in atmosphere which creates an imbalance in carbon cycle. Activities of both natural and humans results in emission of CO_2 in the atmosphere. In this section we have discussed the relevant theories which have contributed to explain CO_2 emission and its effect on environment and economic growth. In addition to this, we have explained the basic relationship among variables and developed a methodology for our study to analysis the influence of economic growth, FDI, urbanization and energy use on CO_2 emission.

The environment quality of any country rest on many factors like quantity of natural resources, net import or export, agricultural or industrial country, structural changes, development stage, sectorial structure etc. Agricultural countries have to bear a cost of depletion in resources because agriculture sector are resource demanding in contrast industrial countries have to face high air, water and land pollution because industrial sector are more pollution demanding.

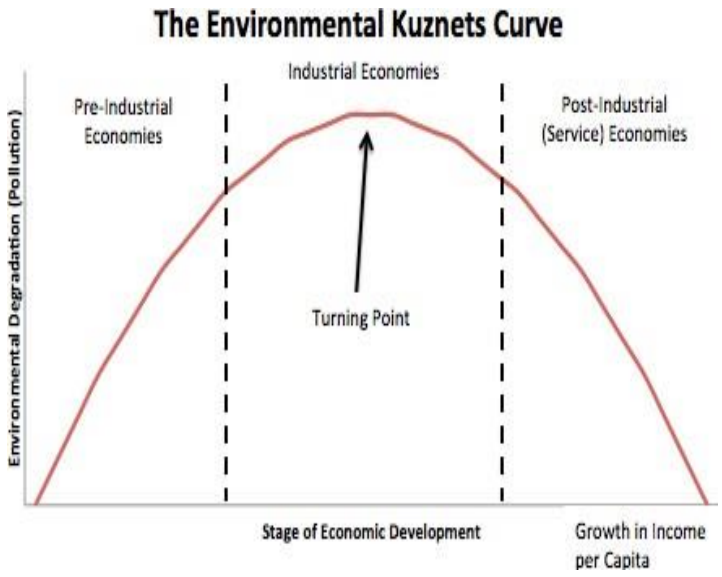
Carbon dioxide emission refers to combustion of fossil fuels, firewood and natural resources to meet our energy demand. Carbon dioxide (CO_2) builds the largest share in production of greenhouse gases. The contribution of artificial greenhouse gases to the environment disturbs the earth's radioactive equilibrium which subsequently depletes natural resources and cause to deteriorate environment quality.

3.2.1 Economic Growth and CO_2 Emission:

Growth in the volume of goods and services produced per head of the population for specific period of time is known as economic growth. As economies grow there is change in countries energy demand, industrial ratio, infrastructure and so many other factors. The environmental Kuznets curve (1991) is link among environmental deterioration and economic growth which states that there is U-shaped (inverse correlation) observed among economic development and environmental deterioration. According to Kuznets curve first increase in real GDP lead to

increase the environmental degradation and after achievement at some specific economic development phase the further increase in Real GDP would lead to mitigate environmental deterioration. This statement presume that at early stages of development people concern about their basic need like food, job, shelter but when countries grow at higher economic development stage their concern shift on the way to good environmental quality. The other opinion directed that industry sector share in Real GDP increases in pre-industrial phase and start diminishing when countries enter in postindustrial phase.

Figure 3.1: Kuznets Curve



Source: Shahrin and Halim (2007:2)

There are three important effects in determination of environmental pollution scale effect, composition effect and abatement effect.

i) Scale Effect

Scale effect which supports that there is increasing and direct association among GDP growth and CO_2 pollutant and used income as indicator for economic activities, as income (GDP) of any country increases economic arrangements required more energy to boost output (real GDP) due to which more CO_2 pollutant produced as by product .This effect held via increased consumption and production of any country.

ii) Composition Effect

Composition effect associated link between economic structure and income level. This effect is only connected with supply side. This effect detailed that as country shift from agriculture phase to industrial phase this structural change cause noticeable environmental variations, and after attaining some specific income point country shift from manufacturing sector toward services sector. As any country‟s economic structure transforms its income

increases. Country transformation revealed the difference between pre-industry and post-industry share in total GDP and country development. Secondly, when country switch toward industrial sector it leads toward more pollution and environmental damage.

iii) Abatement Effect

Abatement Effect is related to both demand and supply side. The individuals of low income country are mostly concern with basic need and not concern toward environment quality. However, the individuals of high income country concern with environmental quality similarly on supply side companies start to invest on technology and equipment which reduces environmental pollution.

3.2.2 CO_2 Emission and FDI:

The impact of FDI on CO_2 emission getting importance day by day. The classical theory of development economics supports for capital investment and technological progress. Foreign companies invest in developing countries typically used up-to-date technology and effective production methods and spend on R&D because in such way companies productivity increases. FDI play a crucial character to expand trade (export) through technological development and productivity enhancement. Some important hypotheses to decide the effect of FDI on CO_2 emission are pollution shelter hypothesis, pollution halo hypothesis and pollution heaven hypothesis.

i. Pollution Shelter Hypothesis

Taylor and Copeland presented the idea of pollution shelter hypothesis which state that environmental instruction has reduced the competitiveness of domestic polluting companies and oblige these companies to relocation of industries. Companies transfer from high environmental cost countries toward low environmental cost countries.

ii. Pollution Halo Hypothesis

Pollution halo hypothesis state that clean technologies and proper environment management will device when foreign companies will invest in host countries, which will leave positive impact on host countries ecological system. In the same way technology spillovers and FDI diffusion process will promote effectively in host countries. Thus investment by foreign countries will lead toward economic development through capital stock, technology handover and through knowledge diffusion.

iii. Pollution Heaven Hypothesis

Pollution heaven hypothesis state that FDI help to promote technology transfer and capital investment in host country but at cost of environmental quality. FDI increases environmental pollution and make a host country a Pollution Paradise. This meant to be a low environmental cost of host country which attracts more investment. Countries from tight environmental regulation move toward poor countries where there are weak guidelines.

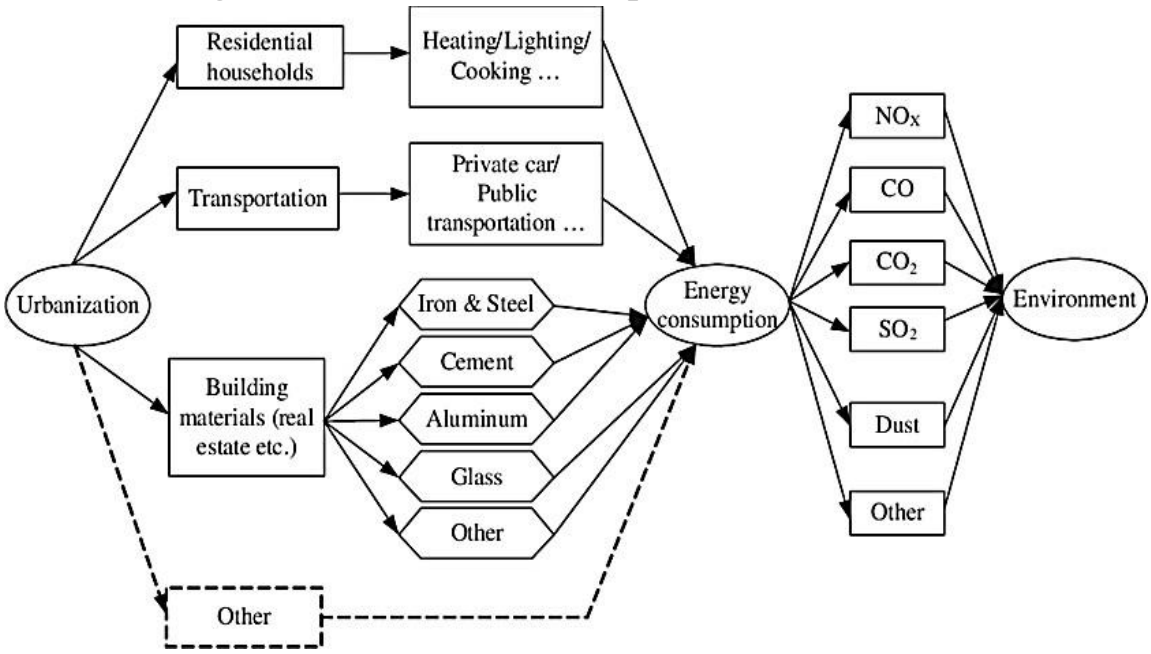
3.2.3 CO_2 Emission and Urbanization

As large cities are engine for economic growth and economic activities there is also adverse impact of growing cities on environmental quality. There are many problems related to

urbanization like improper water management, no proper housing planning, emission from industries and vehicles, destruction of forest, pollution, growing slums, solid waste, trash disposal and so many other which are key factors to deteriorate environment of any country. Theories believe that as country move from agriculture to manufacturing sector or production phase its atmospheric pollution increase with growth of any developing countries.

Some theories suggest that there is linear relationship among pollution and urbanization, and other explore inverted u-shaped relationship among urbanization and pollution which state that at early stage of development, government and individuals only concerned with output and income growth irrespective of environment damages. Once the specific growth of income and output is attained, individuals shift their concern toward better environment quality because bad environment conditions adversely impact living quality and health of individuals. Cities involve in emission of greenhouses gases which deplete ozone layer and cause climate changes. Similarly air pollution contaminate atmospheric sphere which impact intensity and frequency of rainstorm, precipitation and other factors of climate.

Figure 3.2: Urbanization Impact on Environment



Source: (Zhou *et al.* 2012)

3.2.4 CO_2 Emission and Energy Consumption

In global sustainable development goal "climate action" is one of the major goals targeting to minimize the growth of carbon emission and other greenhouse gases. There are different effect of renewable and nonrenewable energy resources on CO_2 emission and environmental conditions. Renewable energy includes sand, hydropower, and water energy. Wind energy and geothermal energy do not contaminate atmosphere and not cause pollution and CO_2 emission. Use of renewable energy resources help to maintain clean and green environment. On other hand non-renewable resources for instance the petroleum, firewood and natural gas are

the key factors to contaminate and pollute environment quality. CO_2 emission badly impact ozone layer which affect the atmospheric condition. Many research studies observed positive and direct correlation among CO_2 emission and energy use, which directed that as countries consume more non-renewable resources its environment will deteriorate. Carbon dioxide emission refers to combustion of fossil gasses, firewood and natural resources to meet our energy demand. Carbon dioxide (CO_2) builds the largest share in production of greenhouse gases which disturbs the earth's radioactive balance which subsequently depletes natural resources and cause to deteriorate environment quality.

3.3 Data Collection

This section explained the source of data, collection of data, definitions and economic theory of variables used in the analysis. We used data for an empirical analysis and it is playing very supportive role for justification of our arguments. In present study we have incorporated tim series data for sample of Pakistan. To estimate the model secondary data is used for Pakistan from 1973 to 2017. Statistics of all variable is composed from World development indicator (WDI) 2019 and International Energy Statistics (IES).

3.4 Variable Description

In study CO_2 emission is used as response variable as a function of four explanatory variables; FDI, energy consumption, economic growth and urbanization. The variables used for analysis are GDP growth (%) as a proxy of economic growth, Foreign direct investment, net inflows (% of GDP) as a proxy of FDI, urban population (%of total) as proxy for urbanization, energy usage (kg of oil equivalent per capita) as proxy of energy consumption and CO_2 emissions (kt) as proxy of CO_2 emission.

Table 3.1: Description of variables

S. No	Variables	Notation	Data Source	Description
1	CO_2 emission	CO_2	World Development Indicator (WDI)	Carbon dioxide emissions are refer to burning of fossil energies, solid, liquid, and gas. It measures in kilo tones.
2	Economic growth	Y	World Development Indicator (WDI)	GDP is the sum of all goods and services produced by all residents in the economy. Annual percentage growth rate is used as proxy for economic growth.
3	Energy consumption	EC	International Energy Statistics (IES)	Energy consumption refers to consumption of primary energy before change to other fuels. It measure in kg oil equivalent of GDP per capita.
4	Foreign direct investment	FDI	World Development Indicator (WDI)	Foreign direct investment refers to foreign investment equity movement in the hosting economy. FDI as percentage of GDP is used proxy of FDI.
5	Urbanization	UB	World Development Indicator (WDI)	Urban population refers to people living in urban areas .The data are collected by United Nations Population Division. Urban population so % of total is taken.

3.5 Statistical Analysis

In this section we have provided the statistical and graphical analysis of all variables uses in the study. Furthermore, in this segment we have analyzed the features of variables, trends of variables and correlation among the variables.

3.5.1 Descriptive Statistics

Table provides the descriptive data of all variables used in model to estimate the results. This table conveys the general setting of all variables. Descriptive analysis comprises the mean and median value, the standard deviation, minimum and maximum values of all variables are tabulated in table 3.2. The data on all variables are from 1973 to 2017 collected from WDI and International Energy statistics (IES).

Table 3.2: Descriptive statistics

	CO_2	ENR	FDI	URBAN	GDP
Mean	88761.84	409.9332	0.775643	31.29898	4.748868
Median	84484.01	427.9854	0.576511	31.58200	4.832817
Maximum	170310.1	285.1780	3.668323	36.44200	10.21570
Minimum	18929.05	285.1780	0.009432	25.08400	0.468373
Std. Dev.	53459.16	76.67002	0.799131	3.327536	2.174082

Source: Author"s own estimation (2019)

The mean value of CO_2 emission is 88761.84 and standard deviation is 53459.16. The least value of CO_2 emission is 18929.05 and the maximum value is 170310.1. Standard deviation of energy consumption is 76.67002 and means value is 409.9332.The 285.1780 and 285.1780 are respective minimum and maximum values. Standard deviation of FDI 0.799131 is and its mean value is 0.775643. The respective minimum and maximum values are 0.009432 and 3.668323. The mean value of urbanization is 31.29898 and standard deviation is 3.327536, the 25.08400 is minimum and 36.44200 is maximum value .Likewise, standard deviation of GDP growth is 2.174082 and means value is 4.748868. The 0.468373 and 10.21570 are respective minimum and maximum values.

3.5.2 Correlation Matrix

In this section we have observed the relationship among response variable and explanatory variable for the period of 1973 to 2017. Correlation is numerical technique to measure linear relationship among two variables. Our dependent variable is CO_2 emission and its correlation with other variables is shown in the table 3.3. This information is necessary to address the issue of multi-collinearity. The results confirmed positive correlation among CO_2 emission and independent variables.

Table 3.3: Co-relation Matrix

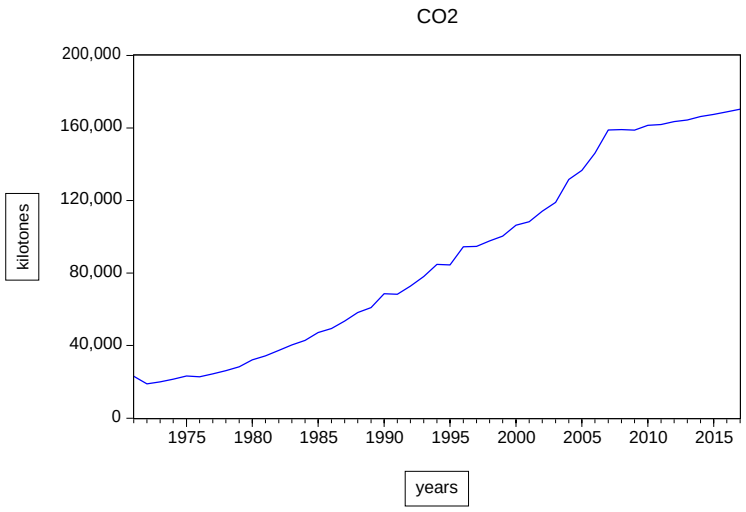
	CO2	ENR	FDI	GDP	URBAN
CO2	1	0.956	0.610	-0.211	0.973
ENR	0.956	1	0.683	-0.198	0.969
FDI	0.610	0.683	1	-0.088	0.563
GDP	0.211	-0.198	-0.088	1	-0.138
URBAN	0.9736	0.969	0.563	-0.138	1

Source: Author"s own estimation (2019)

3.5.3 Trends of CO_2 Emission in Pakistan :

This section contains the graphical analysis of our main dependent variable .The study of trend of included variables in Pakistan is very central to analyze. It tries to find the peaks and troughs in the trends as well as the behavior of the variables with time**.**

Figure 3.3:Trend of CO_2 Emission in Pakistan

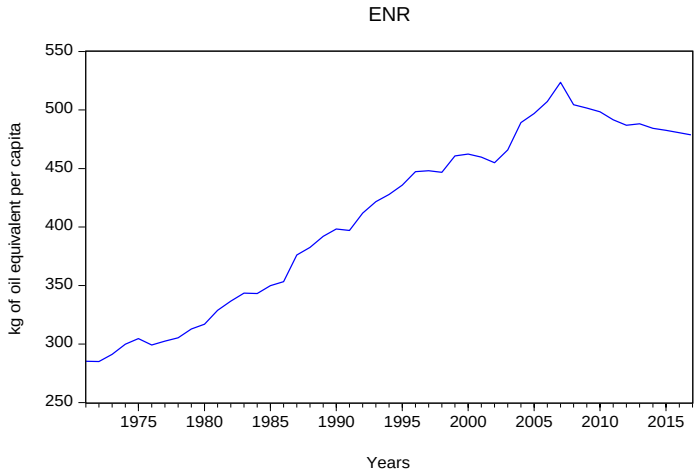


Source: Own analysis (2019)

As CO_2 emission is our dependent variable which is used as proxy of environmental deterioration measure in kilotons, depicts that there is increasing trend in CO_2 emission in the country over the time.

Energy consumption:

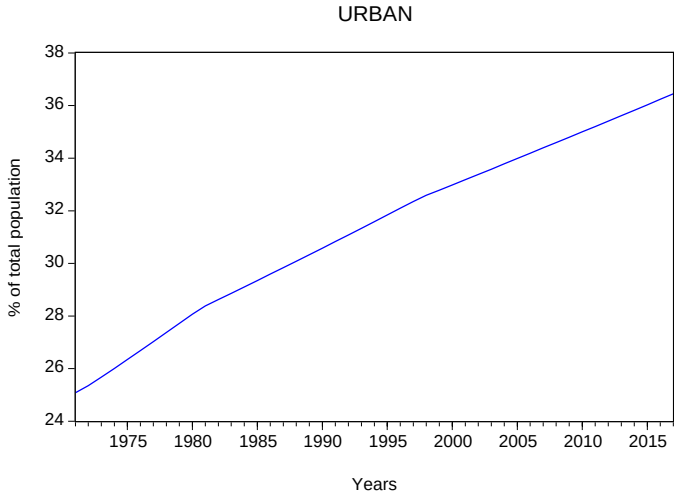
Figure 3.4: Trend of Energy Consumption



The above graph of energy measure in kg of oil per capita employ as representation of energy consumption. Graph depicts increasing trend of energy variable over time.

Urbanization:

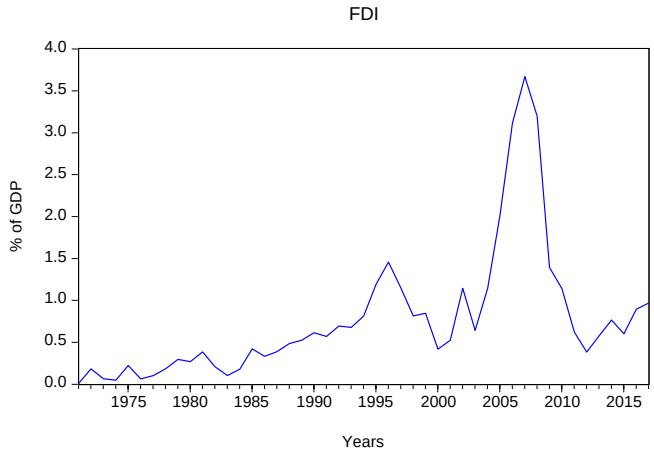
Figure 3.5: Trend of Urbanization



The display of urbanization indicates that there is upward trend in the growth of urban population ratio to total population, and this is the chief cause that leads to increase energy consumption in the economy**.**

FDI:

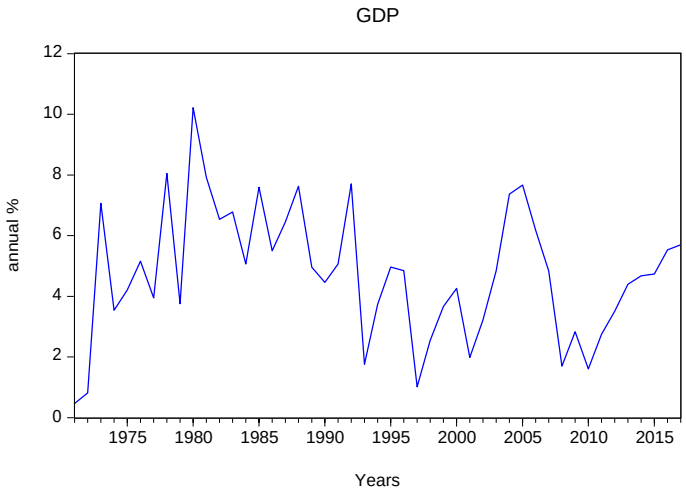
Figure 3.6: Trend of FDI



The above graph shows from 1975 to 2000 there is constant FDI inflow after that increasing trend is observed from 2000 to 2007 however FDI start decreasing till 2013. Mix trend is observed from 2013 to 2017.

GDP:

Figure 3.7: Trend of GDP



The graph reveals that there is no clear trend of GDP growth in the country and there are many fluctuations in the growth of GDP over the time. GDP growth in percentage form is used as proxy for economic growth.

3.6 Conclusion:

In chapter we analyzed the empirical, graphical and numerical analysis of all variables included in study. We discussed collection, statistical, descriptive and graphical analysis. This chapter clarified the source of data, collection of data, definitions and economic theory of variables used in the study. Statistics, numeric facts and figures is very crucial for empirical estimations and main findings.

CHAPTER 4

ESTIMATION METHODOLOGY

4.1 Model Specification

The present study uses following regression model of Hamid (2016), Ali (2016) and Hossain (2014). Based on these explanations the general form of our model is as follow in equation 4.1:

CO_2 emission = f (GDP growth, FDI, urbanization and energy use) **(4.1)**

This model can be written empirically as in equation 4.2:

$$\mathbf{CO_2 = \alpha_0 + \alpha_1 UB + \alpha_2 Y + \alpha_3 EC + \alpha_4 FDI + } \quad \textbf{(4.2)}$$

Taking log form mentioned in equation 4.3

$$\mathbf{ln CO_2 = \alpha_0 + \alpha_1 ln UB + \alpha 2 Y + \alpha_3 ln EC + \alpha_4 ln FDI + } \quad \textbf{(4.3)}$$

Where,

ln = Natural logarithm;

CO_2 = Carbon Dioxide Emission

UB = Urbanization

Y = GDP Growth

FDI = Foreign Direct Investment

EC = Energy Consumption

α_0 = Intercept

$\alpha_1, \alpha_2, \alpha_3, \alpha_4$ = coefficients of variables.

= error term

The present study uses the log form to variables eliminate outliers and larger coefficients. After log form specification interpretation of coefficients also gives us elasticity‟s of variable. Elasticity‟s is best measure to analyze the degree of responsiveness of CO_2 emission by change in any of independent variable at any time. As GDP growth is already in percentage form, so we will not take log of GDP variables, because it doesn‟t make any sense to take log of percentages and growth rates.

From equation we expect a positive sign of all variables between CO_2 emission and explanatory variables. Because all variables used as explanatory variable are chief causes of CO_2 emission in any environment.

4.2 Econometric Methodology

In our present analysis, we are interested to examine the long run link of CO_2 emission with FDI, Y, UB and EC. In this chapter the relevant technique, approaches and estimation technique for time series data are discoursed. To study the co-integration and causality among these variables the ARDL Co-integration and granger causality is applied. In co-integration analysis our aim is to

i. Find the underlying long run relationship.
ii. Study short run dynamics.

iii. Merge the short run and long run study, in specific to conclude whether short run variation contributes to create the long run relationship.

For applying ARDL co-integration technique variables must be integrated at level or order one. So firstly we check the order of integration of variables by applying stationarity tests. Later this we employed the co-integration methodology and the method is given in the following sections.

4.3 Stationarity Test

The first step involved in the co-integration methodology is to examine stationarity of the data by applying different unit root tests. For co-integration, all the variables must be integrated at level I(0) or level I(1). In this study we have discussed and used two unit root tests i.e. Augmented Dickey Fuller and Philips Perron test. The time series variables mostly follow upward and downward trend, so there is need to examine the stationarity of data.

4.3.1 Augmented Dickey Fuller

ADF is improved version of Dickey Fuller, DF test is based on assumption that error term should not be correlated and ADF assumed that in economics mostly variables follow some upward and downward trend and error term may correlated. ADF is better version because it includes extra lagged term of dependent variable and by using this autocorrelation problem may avoid. A ADF stationarity test may be stated as in equation 4.4:

$$\sum \qquad \textbf{(4.4)}$$

Where Y symbolizes the time series variable, t is the time variable, β1, β2 and β3are the expected parameters, Δ represents first difference, α_i denotes estimated parameters of lagged variables and ε_t is the white noise term. In null hypothesis it is assumed that in each time series variable unit root exist however in alternative hypothesis it is assumed that there is no unit root present in time series variables.

H_0: = 0 (There is unit root present in time series variable)

H_1: < 0 (There is no unit root present in time series variable)

Null hypothesis is accepted if time series variable is non-stationary and if the null hypothesis is rejected this confirms that time series variable is stationary or unit root is not present.

4.3.2 Philips Peron Test

The PP test is adjusted version of ADF test and more robust measure to check stationarity in time series data. It adjusts ADF test by such that it ensures that there will be no problem of auto correlation and heteroscedasticity in error term. A simple PP test may be expressed in equation 4.5

(4.5)

In null hypothesis it is assumed that in each time series variable unit root exist however in alternative hypothesis it is assumed that there is no unit root present in time series variables.

H_0: = 0 (There is unit root present in time series variable)

H_1: < 0 (There is no unit root present in time series variable)

Null hypothesis is accepted if time series variable is non-stationary and if the null hypothesis is rejected this confirms that time series variable is stationary or unit root is not present.

4.4 Autoregressive Distributed Lag (ARDL) Model

The objective to estimate the long run and short run parameters of model is accomplish by using ARDL estimation technique which was introduced by Pesaran and Shin (1998). ARDL is a single equation approach. It is simple and concise approach .The most important point in ARDL model is that we do not stick to the conventional definition of co-integration in which all variables must be integrated in same order. ARDL approach has some benefit over the Engle – Granger (1987) test, Johansen (1998), and Philips and Hansen (1990). As ARDL approach is based on the flexible definition of co-integration that run estimation on series integrated at I(0), and I(1). However all other co-integration estimation techniques follow and run series integrated at level (1) which gives biased result of estimators. ARDL methodology for co-integration allows us to get the result of long-run and short-run at the same time. This approach of co-integration has resulted after many progress over the time and desired above the other approaches since it is well-organized in directing the dynamic causes of bias and small sample size. In addition, the ARDL strategy for co-integration also allows controlling or avoiding the endogenity problem. Since this finds that urbanization and GDP growth is stationery at the level, on the other hand energy consumption, CO2 emissions and FDI are stationery at first difference, this study uses ARDL technique to estimate the model

The ARDL model for study is shown in below equation 4.6.

( )

$$\sum_{(\ )} \sum \sum \sum$$

$$\sum \qquad (\ )$$

In above equation CO_2 ,UB,Y ,EC and FDI are focused variables , similarly α_0 ,α_1,α_2,α_3,α_4 , , are long run and short run coefficients.

4.4.1 ARDL Bound Test Approach

ARDL bound testing is employed to verify the overall significance of whether or not a long-term relationship exists between variables, for significance ARDL include all lag variables in their level form. The test follows the F-statistics value to verify the long run relationship .In null hypothesis it is considered that there is no long run relationship compared to alternative hypothesis of existence of long run relationship among variables.

(There is no long-run relationship)

(There is long-run relationship)

In study we compare F-statistics with upper and lower critical value, the lower critical limit supposed that all variables are integrated at order zero; I (0) and upper critical limit supposed that all series are integrated at order one; I (1). If the F-statistic value is above the upper critical limit,

reject the null hypothesis if no long-term relationship, otherwise if the F-statistic is below the low critical limit; accept the null hypothesis of no long-term relationship.

4.4.2 Short run and Long Run Estimators

As ARDL co-integration analysis is applied to study both short-run and long-run relationship among variables. In specification equation there is both short run and long run estimators. The long run estimators are given below in equation 4.7:

$$() \qquad ( )$$

In above equation α_0 , α_1, α_2, ,α_4 are long run coefficients of model.

Similarly, the short run dynamics coefficients from the model can be indicated by result the "Error Correction model" related to long run estimates. Short run expressed as below in equation 4.8

$$() \sum () \sum \sum \sum$$

$$\sum \qquad ( )$$

Where $\mathbf{E_{t-1}}$ characterizes error correction value and ζ denote speed of adjustments. Likewise , are short run co-efficients. The error correction value must be negative and significant. The negative error correction term propose that after any deviation from the long-run, the variables could converge toward equilibrium. In contrast, a positive error correction value specifies that variable would not converge toward equilibrium.

4.5 Granger Causality

Granger (1969) interpreted causality as Variation of Y is the reason for the other X if knowledge of the past history of Y is necessary for the prediction of the future state of X over and above the understanding of the history of X itself. So if X's prediction is enhanced by including Y as a predictor, then Y is said to be an granger cause for X. Mostly it is used to analyze whether one series is valuable for predicting another. Granger is also supportive to examine the feedback system in econometrics in which assumption that X causes Y and Y causes X. Granger test based on hypothesis of no granger cause among variable as null hypothesis against alternative hypothesis that there is granger causality among two variables. The hypothesis results based on p-value or F-statics. The hypothesis is given below:

H_0 = (No granger causality exist among variables)

H_1 = (Granger causality exist among variables)

If the p-value is less than 0.05, reject null hypothesis of no granger causality in favor of alternative hypothesis. In contrast if p-value is greater than 0.05 reject alternative hypothesis of granger causality presence among variable in favor of null hypothesis.

4.6 Conclusion:

In this chapter we have discussed the relevant theories which have contributed to explain CO_2 emission, its effect on environment and economic growth and which factors cause the CO_2 emission. In addition to this, we have developed a methodology for our study to analysis the influence of economic growth, FDI, urbanization and energy use on CO_2 emission. Our empirical results and discussion will be based on methodology and test we have mentioned in this chapter.

CHAPTER 5
EMPIRICAL RESULTS
AND DISCUSSION

5.1 Introduction

In this chapter, we have discussed the relevant estimation results of our area of study. We have empirically examined the correlation between CO_2 emission and the other variables such as FDI, GDP growth, energy utilization and urbanization. The estimation strategy which we have exploited is as follows: firstly, by employing ADF and PP unit root tests we have confirmed that all the variables have same order of integration. Secondly, to examine the short run and long run dynamics the ARDL Co-integration technique is applied. Thirdly, we checked diagnostic test and stability test. Finally run Granger Causality to trace causality between variables. For estimation of our results we have used E-views software.

5.2 Results of Unit Root Tests:

Earlier we have discussed the importance of unit root test for panel co-integration in chapter 4 and test procedure is also explained. The value of t-statistics along with their corresponding probability values are shown in tables below. Schwartz Information Criterion (SIC) is used to select lag lengths for unit root tests. The null-hypothesis for all the unit root tests which we have applied is that there is unit root which mean variable is non-stationary. The alternative hypothesis for all the unit root tests is that there is no unit root means that variable is stationary.

If P- Value is < 0.10, we accept the null-hypothesis which indicates absence of unit root in the series. We have use two unit root test ADF, PP test. Results demonstrated that null hypothesis for all variables are not rejected at I (0), while taking first difference alternative-hypothesis is accepted which indicates that all variables are stationery. The result directs that all variables are integrated of order-level while the level of order they are tied at zero in the first difference. Hence, our variables are co-integrated and have long run association.

Table 5.1: Augmented Dickey Fuller test results

Variables	LEVEL		First difference	
	T-statistics	p-value	T-statistics	p-value
CO_2 emission	0.797005	0.9930	-6.013358	0.0000
Y(economic growth)	-4.838313	0.0003	-10.76806	0.0000
EC(Energy consumption)	-1.737495	0.4061	-5.195520	0.0001
UB(urbanization)	-2.250378	0.1922	-4.569501	0.0005
FDI	-2.795168	0.0670	-4.613184	0.0005

Table 5.2: Phillips perron test results

Variables	LEVEL		First difference	
	T-statistics	p-value	T-statistics	p-value
CO_2 emission	-2.794659	0.2065	-6.112312	0.0000
Y(economic growth)	-5.017328	0.0009	-12.67537	0.0000
EC(Energy consumption)	-1.579588	0.4848	-5.603989	0.0002
UB(urbanization)	-6.545966	0.0000	-11.168925	0.0000
FDI	-2.666901	0.2545	-4.177643	0.0099

Table 5.3: Summary of unit root test

Variable	**(ADF) test**	**(PP) test**	**Decision**
CO_2 emission	I(1)	I(1)	I(1)
Y(economic growth)	I(0)	I(0)	I(0)
EC(Energy use)	I(1)	I(1)	I(1)
UB(urbanization)	I(0)	I(0)	I(0)
FDI	I(1)	I(1)	I(1)

Source: Author"s own estimation (2019)

5.3 ARDL Bound Test:

The test of the existence of a long-run equilibrium relationship among variables was conducted using the ARDL bound analysis. Results from a bound test showed that there is a long-run equilibrium relationship among variables at the 1% significance level. Specifically, the F statistic calculated for the model (7.370319) is greater than the critical upper limit values of 3.52, 4.01, 4.49 and 5.06 at significance levels of 10%, 5%, 2.5% and 1% respectively. The F-statistic was higher than the critical upper limit values in the model and approves that there is a stable long-term relationship between the variables. The result shown in table 5.4

Table 5.4: ARDL Bound Test:

Test Statistic	Value	K
F-statistic	7.370319 ***	4
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.74	5.06

Note: *** implies rejection of the null hypothesis at 1% level of significance.

Source: Author's own estimation (2019)

5.4 Results of Long Run Estimation:

The co-efficient of energy consumption shows that 1% rise in the energy consumption cause 1.1 % increases in CO_2 emission at 1% significance level. This displays that energy consumption is chief cause in creation of carbon dioxide. The positive relationship among CO_2 emission and use of energy is studied by Hossain & Hasanuzzaman (2014), Ali *et al.* (2016) and Linh & Lin (2014).The co-efficient of FDI variable represents that 1 % rise in the foreign direct investment leads to 0.1 %increase in CO_2 emission at 1% significance level. FDI is positively related with CO_2 emission which confirms the pollution heaven hypothesis that states FDI help to promote technology transfer and capital investment in host country but at cost of environmental quality. The positive and significant relationship between FDI and CO_2 emission is studied by Acharyya (2009), Chandran & Tang (2013) and Omri *et al*. (2014).Similarly, the co-efficient value of urbanization shows that 1 % rise in urbanization leads to 3.7 % increase in CO_2 emission at 1% significance level. Studies by Dogan & Turkekul (2016), Saidi & Mbarek (2016) and Behera(2017) also verifies that growing urbanization cause environmental pollution .Also, 1% rise in GDP growth leads to 0.01 % rise in CO_2 at 5% significance level. The positive and significant results among GDP growth and CO_2 emission confirms scale effect which states that there is increasing and direct association among GDP growth and CO_2 pollutant as GDP of any country increases economic activities required more energy to boost output (real GDP) due to which more CO_2 pollutant produced as by product. Empirical studies by Acharyya(2009), Wang *et al*. (2018), Khobai (2017) and Leitao (2014) also proves that economic activities generation is one of main factor in emission of carbon dioxide harmful pollutant. The overall results are significant and prove the long run association among CO_2 production and other predictor variables urbanization, GDP growth, FDI and energy usage. The result show in table 5.5.

Table 5.5: ARDL Long Run Result

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGENR	1.150***	0.232	4.947	0.0000
LGFDI	0.125***	0.037	3.365	0.0026
LGURB	3.796***	0.338	11.201	0.0000
GDP	0.016**	0.006	2.663	0.0136
C	-8.615***	0.765	-11.250	0.0000

***, **, * represents 1%, 5% and 10% significance level.

Source: Author"s own estimation (2019)

5.5 Results of Short Run Dynamics with ECM

The short run analysis with an error correction model (ECM) term combined is estimated with in the ARDL framework. It tells the direct effect of GDP, FDI, energy consumption, urbanization on carbon dioxide production. The ECM determines the speed of correction to reoccurrence to equilibrium when there is any abnormality. The result display in table 5.6.

Table 5.6: ARDL Short Run Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LGENR)	0.866***	0.210	4.117	0.0004
D(LGENR(-1))	0.804***	0.253	3.173	0.0041
D(LGENR(-2))	-0.517**	0.206	-2.508	0.0193
D(LGFDI)	0.023	0.021	1.084	0.2888
D(LGFDI(-1))	-0.049**	0.018	-2.627	0.0147
D(LGFDI(-2))	0.007	0.017	0.427	0.6730
D(LGFDI(-3))	-0.054***	0.014	-3.643	0.0013
D(LGURB)	9.508*	6.812	1.395	0.1756
D(LGURB(-1))	3.166	19.419	0.163	0.8718
D(LGURB(-2))	10.824	15.557	0.695	0.4933
D(LGURB(-3))	-15.735**	7.522	-2.091	0.0472
D(GDP)	0.003*	0.001	2.001	0.0567
D(GDP(-1))	-0.009***	0.001	-4.626	0.0001
CointEq(-1)	-0.718***	0.142	-5.050	0.0000
Cointeq = LGCO2 - (1.1509*LGENR + 0.1258*LGFDI + 3.7964*LGURB +0.0166*GDP - 8.6151)				

***, **, * represents 1%, 5% and 10% significance level.

Source: Author's own estimation (2019)

The dynamic of short run is considered by deriving the results from the ECM technique. According to ECM theory, the sign of ECM coefficient should be negative and statistically significant. From the result in Table 5.4 show that coefficient of the ECM is negative and significant and thus approves the presence of the long run equilibrium association amongst the variables in the co-integration test and also indicates the estimated model is steady. It expresses how the variables in the model converge to long run equilibrium after a shock in the short run. The end result tells that the equilibrium in the long term will be matched by approximately 71% after a shock short run, reflecting the very high rate of correction in the long term. This rapid speed of adjustments can be suggested that it took a very short time to adjust to the $C0_2$ emissions when there will be shocks.

In short run energy consumption is mixed positive and negative related with CO_2 emission, it means in short run high energy demand may or may not leads to high CO_2 emission. Similarly, FDI is both negative and positive associated with CO_2 emission, Urbanization and

GDP growth are positive and negative co-integrated with CO_2 emission in short run which show that urban expansion and GDP growth may or may not key determinants which demand high energy use that ultimately produce CO_2 global pollutant.

5.6 Diagnostic and Stability Tests

In this section, we check strength of our results in order to investigate the stability of our model. The precise functional form of the model was identified and the avoidance of serial correlation and heteroscedasticity. The test statistics for the several tests is anticipated to be statistically insignificant to confirm the absence of these econometric problems. The result of the diagnostic test are displayed in table 5.7

Table 5.7: Diagnostic and Stability test result

Test	F- statistic	Prob. Values
Serial Correlation	1.259	0.3077
Heteroscedasticity	0.675	0.6813
Normality	4.217 (JB –value)	0.121391
Functional Form	0.514	0.6126
CUSUM	Stable	
CUSUMQ	Stable	

Source: Author"s own estimation (2019)

The test of serial correlation based on the Godfrey Serial correlation LM test among the residuals confirms the absence of serial correlation since the F-Statistic value is 0.3 >0.05 proves statistically insignificant indicates that there is no serial correlation. Breusch-Pagan-Godfrey hetroskedasitcity test also reported a statistically insignificant as its F-statistics value is 0.6>0.05 which indicates that there is no hetroskedasticity, thus signifying the nonexistence of heteroskedasticity among the error terms. The Ramsey-reset stability test results also shows that the models have no issues with the functional form and thus a correct model has been specified. The Ramsey-reset test F-statistics value is 0.6126>0.05 proves that there is correct misspecification and accept the null hypothesis of correct functional form. Also the normality test based on the Jacque-Bera test indicates the variables are normally distributed as JB calculated is 4.217478 less than JB statistics 9.48(chi statistics) so reject the alternative hypothesis that variables are not normally distributed. The results of diagnostic tests indicate that model has no auto-correlation and the parameters of the model are stable. Moreover, the graph of CUSUM & CUSUMSQ test also confirms that structural parameters are stable as the recursive residuals lie within the two critical lines. Results display in figure 5.1 & 5.2

Figure 5.1: CUSUM Test

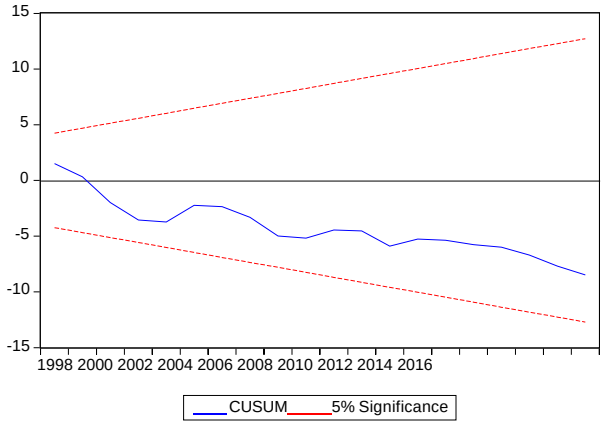
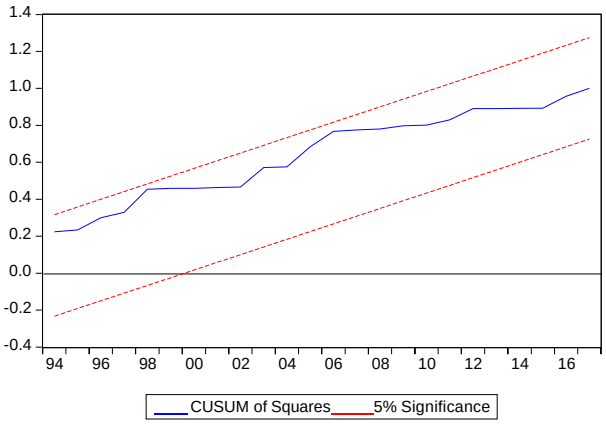


Figure 5.2: CUSUM Test



Source: Author estimation test (2019)

5.7 Granger Causality:

Estimated result show that there is two-directional causality among GDP growth and CO_2 emission which show that increasing economic growth cause more production of CO2 pollutant because increasing economic growth required more energy to boost output (real GDP) due to which more CO_2 pollutant produced as by product . This effect held via increased consumption and production of any country. Similarly, bi-directional estimated directed from CO_2 emission toward FDI which demonstrates that as there is no environmental and pollution cost in Pakistan which ultimately cause to attract FDI. Previous empirical studies by Omri (2013) and Linh & Lin(2014) also deduce two-directional causality among GDP growth and CO_2 emission, among FDI and CO_2 emission. Correspondingly there is one-directional causality from energy consumption toward CO_2 emission as energy demand is mostly based on non-renewable resources which cause more CO_2 emission and same results studies by Omri (2013) and Khobai (2017). Though one-direction causality observed from CO_2 release toward urbanization. The estimated results show in table 5.8.

Table 5.8: Granger Causality

	F-statistics	P-value	Inferences
$\Delta lnCO_2 \rightarrow \Delta lnEC$	0.27659	0.7598	Uni-directional causality ($EC \rightarrow CO_2$)
$\Delta lnEC \rightarrow \Delta lnCO_2$	3.58899**	0.0368	
$\Delta lnCO_2 \rightarrow \Delta lnFDI$	4.49527***	0.0039	Bi-directional causality ($FDI \leftrightarrow CO_2$)
$\Delta lnFDI \rightarrow \Delta lnCO_2$	2.27168*	0.0747	
$\Delta lnCO_2 \rightarrow \Delta lnUB$	5.40576***	0.0084	Uni-directional causality ($CO_2 \rightarrow UB$)
$\Delta lnUB \rightarrow \Delta lnCO_2$	1.47045	0.2420	
$\Delta lnCO_2 \rightarrow \Delta Y$	3.09803*	0.0561	Bi-directional causality ($Y \leftrightarrow CO_2$)
$\Delta Y \rightarrow \Delta lnCO_2$	7.07297***	0.0023	

Note: ***, **, * indicates significance at 1%, 5% and 10% respectively.

Source: Author"s own estimation (2019)

5.8 Conclusion:

In this chapter, we have discussed the relevant empirical results of our area of study. We observed the correlation among CO_2 emission and the other variables such as FDI, GDP growth, energy utilization and urbanization. Results of the short run and long run dynamics have been estimated by using ARDL Co-integration technique. Granger Causality is employed to trace causality between variables. Empirical results will be very considerable to explain the main objective of study and for policy recommendation.

CHAPTER 6

CONCLUSION & POLICY RECOMMENDATION

6.1 Conclusion:

In this section we have determined the observed findings of our study. In our analysis we have used four factors to measure the CO_2 emission and factors are GDP growth, urbanization, FDI and energy utilization. On the basis of these factors we find out estimated time series co-integration we have first applied unit root test than ARDL co-integration approach. Furthermore, we have used ECM for short run estimation and granger causality. In model, the empirical results indicate that few variables are non-stationary at level and must be integrated at level one. ARDL bound test confirm that variables are co-integrated and there exist long run association.
In the end we have diagnostic testing done to prove the stability and reliability of our estimates.

The results of model indicate an existence of relationship among CO_2 emission, GDP growth, urbanization, FDI and energy consumption. The results indicate that 1 % increase in economic growth, urbanization, FDI and energy consumption cause 0.01%, 3.7%, 0.1%, 1.1%respectively increase in CO_2 emission. This infers that GDP growth, urbanization, FDI and energy consumption are key factors of CO_2 production.

. The ECM value indicates that the long-run interaction will be corrected by approximately 71% after the short shock, which represents the maximum speed of adjustment over the long term. The outcome of Granger causality shows that there is is two-directional causality among CO_2 emission and economic growth similarly among FDI and CO_2 emission which demonstrate that economic actions FDI influx are key causes of global pollutant CO_2 emission. Correspondingly, there is one-directional causality as of energy consumption headed for CO_2 emission, depicts that energy is leading cause in CO_2 production.

6.2 Limitations and Future Prospects

In this study, we have made every effort to conduct the research in the best possible way on the occasion, methods and time. There are, however, some aspects of research that can be improved. Although the indictors used in the study covered many important aspects but still there is need to study more indicators to focus environmental concerns. Our analysis suggest general findings, future work might analyze the alternative indictors and channels which can crucial for sustainable economic growth.

6.3 Policy Recommendation

On the basis of empirical findings following policy inferences can be deduce from the results:

1. For reduction of CO_2 emission policy makers should implement the use of clean and efficient energy, Pakistan should have an energy development project which should emphasis to shift from nonrenewable energy resources to renewable energy resources.
2. Policymakers should levy carbon pollution tax to reduce the carbon dioxide emission.
3. Pakistan should focus not only increasing FDI inflow as its contribute in economic growth but also device safeguard measure to save environment and should consider the environmental impact of FDI inflow before any FDI investment .
4. There must be policy for energy saving awareness which must targeted local consumers and industrialist that how to use and save energy in order to improve environment conditions.

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