SPILLOVER EFFECT OF ECONOMIC GROWTH FACTORS ON ECOLOGICAL FOOTPRINT FOR ASAIN COUNTRIES. NEW EVIDENCE FROM SPATIAL ECONOMETRIC ANALYSIS

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CERTIFICATE

This is to certify that this thesis entitled: **"Spillover Effect of Economic Growth Factors on Ecological Footprint for Asian Countries. New Evidence from Spatial Econometric Analysis"** submitted by **Qaisar Shahzad** is accepted in its present form by the School of Economics, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree in Master of Philosophy in Economics.

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Author’s Declaration

I, **Qaisar Shahzad,** hereby state that my M-Phil thesis titled **“Spillover Effect of Economic Growth Factors on Ecological Footprint for Asian Countries. New Evidence from Spatial Econometric Analysis”** is my own work and has not been submitted previously by me for taking any degree from Pakistan Institute of Development Economics or anywhere else in the country/World.

If my statement is found to be incorrect even after my Graduation, the university has the right to withdraw my M-Phil degree.

Date………………………

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Dedication

To my parents, ***Amal Sherin and Gul Mina***

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Though this thesis is associated with the author's name, it reflects the dedication, guidance, support, skills, and knowledge of many. Some of the major contributors of this work are acknowledged here as it would be difficult to mention all the individuals; still, their contribution is pivotal.

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ABSTRACT

Ecological degradation is the enhancement of anthropogenic activities to achieve sustainable economic growth. Higher economic growth requires more energy, material, and infrastructure, leading to an ever-greater level of environmental degradation and the emission of dangerous gases. With the fluctuation in economic growth and the desire to attain a long-term high growth rate, every country provides a significant incentive for the industrial sector, the primary source of mitigating ecological footprint. Asian countries are highly vulnerable to climate change, and its impact is observed economically and socially. This study examines the impact of economic performance on the ecological footprint using a spatial econometric technique for 25 Asian countries from 1990 to 2017. The advantage of the spatial econometric technique is that it provides a way to test and accommodate various forms of dependence among countries. The Moran's I test is used to check the spatial dependency. The results indicate positive spatial dependence, suggesting that highly polluted neighboring nations influence the home country's environment. The results show that Environmental Kuznets Curve and Pollution Heaven Hypothesis hold in Asian countries. The results show that environmental degradation is positively related to energy consumption because energy is produced from fossil fuel, considered the primary emission source. Human capital has a positive and considerable impact on the ecological footprint. Environmental degradation is not a local issue. But it is a geographic issue and a challenge for world economies to mitigate its negative impact on livelihood, which requires international cooperation. This cooperation will help policymakers and environmental protection agencies to understand the importance of these issues and suggest solutions to different climate change scenarios. Last but not least, the investment and improvement in human capital mean an increase in the education level will help alleviate poverty and enhance awareness among people about environmental degradation.

Key Words: Ecological Footprint, Human Capital, Environmental Kuznets Curve, & Anthropogenic Activities

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LIST Of ABBREVIATION

FDI	Foreign Direct Investment
EKC	Environmental Kuznets Curve
EFP	Ecological Footprint
GDP	Gross Domestic Product
GHS	Green House Gases
PHH	Pollution Heaven Hypothesis
SLM	Spatial Lag Model
SEM	Spatial Error Model
SDM	Spatial Durbin Model
DE	Direct Effect
IDE	Indirect Effect
TE	Total Effect

Chapter 1

INTRODUCTION

1.1 Background of the study.

The primary cause of ecological[1] degradation is the enhancement of anthropogenic activities to achieve sustainable economic growth. Higher economic growth requires more energy, material, and infrastructure, leading to an ever-greater level of environmental degradation and the emission of dangerous gases. The rise in GHG has adversely affected human health and reduced productivity. According to the International Energy Agency (2017) report, the top 25 developed countries were responsible for 80 percent of global emissions in 2012. Also, 80 percent of emissions are predicted to be emitted by low-income countries in the future. In 1990, the United States was the leading producer of carbon emissions at 23 percent, followed by Japan, 5.72 percent, OECD[2], 24 percent, China 11 percent, India 3 percent, and Russia 0.94 percent. In 2018, the situation was very different, and the emissions[3] level was reduced in developed countries (U.S. and Japan to 15.2 percent and 3.4 percent). In contrast, in developing countries like Saudi Arabia, 1.7 percent, Russia 4.6 percent, India 7.3 percent, and China 27 percent. It indicates that developed

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[1] The ecological footprint is a systematic phenomenon, focused on six land use categories, namely cropland, grassland, forest land, fishing grounds, built-up land, and carbon footprint, designed to track the aggregate pressure of anthropogenic activities on the environment (Ewing et al., 2010).

[2] Organization for Economic Co-operation and Development (consists of 37 countries such as They are Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, and the United Kingdom).

[3] Energy-related emissions are those produced by the combustion of fossil fuels. Although this is the main anthropogenic source, other important sources include net deforestation and cement production

countries have accomplished their goal of protecting the environment and achieving sustainable economic growth. Still, developing countries are going in the opposite direction because they destroy nature with low economic growth. The most severe effects have been observed in developed countries in economic and social terms. Developing countries is considered an emerging economy and more vulnerable to environmental degradation due to higher emissions to achieve sustainable economic growth for a better future. Developing countries have done reform in environmental regulation and signed the Climate Change program of the Kyoto Protocol. But failed to meet these two goals' objectives because energy is generated from non-renewable sources such as coal and oil through conventional techniques. The three fundamental problems of any economy, such as environmental degradation, economic growth, and society's welfare, are closely interrelated and must be addressed for a better life in the future (Environment Asia, 2015)

For a variety of environmental indicators, i.e., CO_2, SO_2, air, and water emissions, hazardous solid and municipal waste, biodiversity, the Environmental Kuznets Curve have been calculated in the literature (Galeotti et al., 2006; Kaufmann et al., 1998; Leitão, 2010; Maddison, 2006; Rupasingha et al., 2004). Its most basic technique involves regressing CO_2 emission or concentration and GDP per capita & its square term (Grossman & Krueger, 1993). This shows that one might expect that environmental degradation increases when the economy begins to expand its production. Eventually, however, a threshold would be reached after which environmental quality improves. This relationship is indirectly related to energy use (Mirza & Kanwal, 2017). Ahmad et al. (2016) higher energy consumption is supported by higher economic growth and emits more CO_2 gas. Furthermore, the inflow of foreign direct investment is also considered the main component of economic growth and environmental degradation in the home country (He, 2006; Liang, 2008). Also, foreigners' massive investment in non-renewable energy projects is a prior source of emissions (Bano et al., 2018). In developing countries, a significant proportion of FDI has gone to pollution-intensive industries due to flexible regulation and causing severe environmental problems (Li & Zhang, 2014). Due to free trade policies, high-income countries take advantage of international trade to reduce sound pollution due to strict regulations in their home country (Carvalho et al., 2013; Mehra & Das, 2008). Several studies have shown that the "U-shape" trend is partly or largely a result of the effect of a trade by exporting pollutant/dirty industries (Rothman, 1998; Stern, 2004). More specifically, international trade provides how polluting industries can be moved from high-income countries to low-income countries.

The novel feature of this study is the inclusion of a spatial econometric in which everything is linked to everything else. Still, nearby things are strongly correlated than they are too distal things (Tobler, 1970). Spatial dependence indicates that one observation is strongly dependent on other cross-section observations. Pollution, notably air pollution, maybe spatially dependent because it can quickly pass or flow across countries or national borders. The absolute position and the relative location between the various regions determine the degree and characteristics of spatial dependence (Anselin & Bera, 1998). Conversely, the time or panel series model only considers individual variables' effects and ignores spillover, which has direct, indirect effects, and spatial dependence on another area. According to Sampson (2018), a spatial econometric is making its way in environmental economics. Environmental policies are shifting due to changes in the policies of the neighboring country. It leads to countries mimicking each other's environmental laws and procedures. For example, the U.S. environment standard improved adjacent regions' environment quality (Fredriksson & Millimet, 2002). For example, Hao et al. (2016) used a spatial econometric model to evaluate the spatial dependence of coal consumption in the Chinese provinces; You and Lv (2018) also used this methodology to examine globalization's spillover impact. It demonstrates the significance of spatial dependency within the region for a policymaker to fix the environmental issue.

1.2 Research Gap.

To our best of our knowledge and reading literature, no one has investigated the Environmental Kuznets Curve and Pollution Heaven Hypothesis for Asian countries. The pollution Heaven Hypothesis is main environmental issue related to the inflow of Foreign direct investment. Most environmental research uses CO_2, SO_2, etc., as a proxy for environmental degradation by using time series and panel techniques (Bano et al., 2018; Gorus & Aslan, 2019; Hassan et al., 2019; Khan et al., 2019). However, it represents a small part of environmental degradation (Al-Mulali et al., 2015), but the ecological footprint is thus a more accurate measure for calculating environmental degradation than CO_2 emissions (Ahmed & Wang, 2019; Uddin et al., 2017). The variable ecological footprint as a proxy of environmental degradation has been ignored in the literature of spatial econometric. Environmental degradation is not a problem of one nation but is a problem for the entire world. This research would close this gap by using the ecological footprint as a dependent variable using a spatial econometric technique.

1.3 The objective of the Study.

- The main objective is to find the Environmental Kuznets Curve for Asian Countries using Spatial Econometric.
- Secondly, we will also analyze the Pollution Haven Hypothesis.
- Finally, this study suggests the policies tackle the environmental issue and low-cost policies.

1.4 Significance of the Study.

Environmental degradation is a global phenomenon, not a problem of the individual country. This research will help the Ministry of Climate change of developing economies achieve the 2030 objective of Sustainable Development Goals (SDG). The difference in the environmental policies is a result of changes in the policies of a neighboring state. Government people and bureaucrats should continuously evaluate the environmental policies of their neighboring countries to reduce the cost of decision-making and legitimize their action, mainly when there is uncertainty regarding these policies' effects. Environmental quality can improve in response to the improvement in neighboring countries' environmental standards. The investment in human capital will help policymakers achieve high productivity and reduce environmental degradation issues such as climate change, GHG, etc. Furthermore, this study will help the economy understand critical conditions clearly and leave enough room for the plan to increase energy efficiency and effectively use foreign direct investment.

1.5 Organization of the Study.

This study is divided into six parts. Chapter 1, "Introduction," offers the importance of environmental degradation, including the Study's Significance, Research objectives, and Research Gap. Chapter 2, "Literature Review," provides information on theoretical and empirical literature as well as on spatial econometrics literature. Chapter 3 is about qualitative assessment and answer of interview. Chapter 4, "Data and Methodology," offers extensive information on the variable measurement and its sources, the econometric model, and the technique used to estimate the model. Finally, Chapter 5 is about Results & Discussion, and Chapter 6 is about the Conclusion.

Chapter 2

LITERATURE REVIEW

2.1 Introduction.

This chapter is divided into two sections, where Section 1 deals with theoretical literature review related to environmental degradation and Section 2 deals with the Empirical literature review. Section 2 is further divided into the Empirical literature of the panel and time-series study. Furthermore, Section 2 also provides the Empirical literature review of spatial econometrics related to environmental degradation. The conclusion is eventually reached at the end of this chapter, which will summarize the entire chapter.

2.2 Theories Related to Environmental Degradation.

The topic of climate change and environmental conservation for both current and future generations is a global concern. It is referred to as human activities contributing to environmental degradation (World Bank, 2018). The increase in environmental degradation, the loss of natural resources, etc., is primarily due to anthropogenic activities (IPCC, 2014a.

2.2.1 Environmental Kuznets Theory.

The Kuznets Curve is the bell-shaped pattern or inverted U-shaped relationship between per capita income and income inequality. The definition of the Environmental Kuznets curve was first presented in the literature by Panayiotou (1933). Later, the winner of the Nobel Prize "Simon Kuznets" in 1971, delivered his opinion that income disparities are rising along with a rise in economic growth at the beginning. Still, at the end of the threshold, the trend declines with high economic growth (Kuznets, 1955). Similarly, the U-shape trend was first observed in the relationship between economic growth and environmental degradation in the early 1990s (Grossman & Krueger, 1993; Panayotou, 1993; Shafik & Bandyopadhyay, 1992).

A large number of empirical and theoretical literature on the independent research of the EKC is available. The literature's Environmental Kuznets Curve explains the inverted U-shape relationship between GDP per capita and per capita emission. Environmental eradication rises at the first stage of increased per capita income (at this stage, the Scale Effect is dominant). When it reaches the maximum level, it raises the environment's quality with high economic growth (at this stage, compositing and technique effect is dominant).

Stern and Common (2001) found an inverted U-shape trend in high-income countries and noted a monotone increase in the relationship between per capita GDP and per capita emissions. The ECC has different results for each nation Farhani et al. (2014); Galeotti et al. (2009) also provide empirical proof of the current U-shape Curve. At the same time, Balsalobre-Lorente et al. (2018), Friedl and Getzner (2003), Özokcu, and Özdemir (2017) affirm the validity of the N-shape relationship between C02 emissions and economic growth.

2.2.2 Pollution Heaven Hypothesis.

The pollution heaven hypothesis stated that transfer of technology or produced the pollution sound in countries where environmental regulation is flexible. Then production of products or transfer of technology due to trade liberalization converts these countries into pollution heaven. The free trade agreement provides a way for the developed economy to transfer polluted industries into developing economies. The U-shape curve of EKC might primarily affect the trade distribution of polluting industries (Stern, 2004).

2.3 Theoretical Literature Review.

Since the last few decades, many research studies have explored the relationship between economic growth, energy usage, and environmental quality, leading to severe discussions between environmental economists and researchers.

Energy is considered the critical engine of economic development and causes emissions but depends on energy sources. The energy produced from fossil fuels will result in high greenhouse gas emissions, while renewable energy sources will improve the atmosphere's quality. Bölük and Mert (2014) provide empirical proof of renewable energy's positive effect on CO_2 emissions.

Also, water production often adversely impacts the ecosystem by using resources to deplete groundwater and the drainage of wastewater from rivers. Growing demographic dynamics and economic growth place more pressure on water withdrawal from the ground to increase C02 emissions. Lofman et al. (2002) address the vital importance of the energy needed to extract water and meet the end-user. Before use, treatment involved a large amount of energy from generators, such as natural gas in California, released hazardous gases that lead to global warming and air quality degradation. Wang et al. (2012) found that groundwater is leading to GHS in China.

Similarly, Rafindadi et al. (2014) have concluded a positive relationship between energy usage, air pollution, and water supplies for ten developing countries in Asia-Pacific. The two essential mechanisms of water extraction affect environmental quality. Continuous water withdrawals contribute to a reduction in soil moisture. Soil moisture can absorb carbon, but underground water's continuous extraction decreases soil moisture and releases NH_4 & CO_2 into the atmosphere, causing environmental degradation. The extraction of water causes the quality of the groundwater to fall as a result of saltwater intrusion. Furthermore, industrial waste is dumped into the river, and water cannot be used directly. Still, it required a significant amount of energy for treatment and contributed to the emission of C02 (Zakkour et al., 2002).

Environmental deterioration and economic development are closely associated with the developing economies of low per capita countries. Human activities create CO_2 emissions to enhance economic growth (Shukla, 2017; Wang et al., 2017). Anthropogenic activities such as coal-burning (Xu et al., 2016), waste fuel consumption, i.e., an old tire and textile waste (Shao et al., 2017), and two-stroke and other polluting vehicles on the road, Hao and Liu (2016); Lin et al. (2018) are all considered to be the leading cause of air pollution. The increasing proportion of PM 2.5 in the atmosphere poses a higher health risk and is most likely to cause lung cancer, skin disease, and heart attack (Xu et al., 2013). On the other hand, Salim et al. (2017) found that the decline in energy consumption was attributed to human resources. Human capital makes people aware of renewable energy through schooling, skilled labor, creativity, etc. (Kandpal & Broman, 2014). Desha et al. (2015) prove that human capital with experience and knowledge can strictly abide by environmental rules and regulations. Manderson and Kneller (2012) found that the company's investment in preserving environmental standards would be lower due to a more significant number of qualified human resources, i.e., a rise in secondary and average school enrollment to reduce CO_2 emissions. Enhancing human resources, i.e., growing skills, creativity in new technology, competitiveness, and the future labor force, would increase energy efficiency and per capita emissions over the long term. The Solarin and Bello (2018) study note that strict C02 emissions policies and awareness-raising among people about using fuel-efficient technologies are one step towards positively affecting the ecological footprint in 128 countries.

Trade openness in foreign direct investment is a crucial factor in environmental deterioration (Ahmad et al., 2016; Dogan & Turkekul, 2016; Farhani et al., 2014), demonstrating the relationship between trade openness and the environment is positive and negative depending on the pollution haven hypothesis. FDI is considered the critical engine of economic growth and investment in the economy's infrastructure but contributes to pollution through two channels. The possible mechanism by which the pollution theory of Heaven is based on strict environmental legislation in high GDP per capita countries is moving their contaminated manufacturing industries to low GDP per capita countries where environmental regulation is flexible.

The relation between human capital and economic growth plays a crucial role in holding the pollution heaven hypothesis. According to Lan et al. (2012), human capital plays a bridge between FDI and per capita emissions. However, PHH is not valid for high levels of human capital in the regions. A low per capita country with flexible regulation attracts FDI to increase economic output and its environmental effects. In the empirical literature, Acharyya (2009) confirms the validity of PHH. He found that provinces with low human resources (uneducated) contribute to heaven's pollution hypothesis.

Conversely, some studies indicate that the inflow of FDI has numerous benefits in terms of economic development and the transition of energy-efficient and environmentally sustainable technologies, which would enhance environmental health. Shahbaz et al. (2015) studied the relationship between FDI and the environment's quality in countries separated based on income levels. The findings indicate that FDI contributes to environmental deterioration in low-income countries and increases the ecological rate in high-income countries.

Contrarily, stringent environmental rules and regulations have the opposite effect on environmental quality. Cole et al. (2005) reported that the introduction of environmental legislation in the U.K. manufacturing sector has substantially reduced air pollution. Furthermore, the Clean Air Act in South Korea, Lee et al. (2018), banning road vehicles and placing a high fine on coal-burning, improved air quality in China (Xu et al., 2018). European Union countries obey environmental laws due to the rise in imports of pollution-intensive products from emerging economies. It led to an increase in air pollution in developing countries, influencing the atmosphere's quality and human life expectancy (Bagayev & Lochard, 2017).

For high economic growth, the government attracts more and more FDI to increase research and development through financial liberalization (Frankel & Romer, 1999). In developing countries, financial progress increases economic growth, but the impact on pollution and environmental issues is growing (Jensen, 1996). Furthermore, stringent ecological policies raise the cost of production. Therefore, pollutant factories and companies migrate to developing countries where flexible environmental regulation transforms them into highly polluted countries. Dasgupta et al. (2001) suggest that a highly structured financial system helps the organization minimize CO_2 emissions. Tamazian et al. (2009) concluded that developing countries' economic growth plays a crucial role in reducing environmental degradation. Besides, the trend of CO_2 emissions is declining due to the high level of FDI. The development of the capital market and banking sector requires strong policies to deliver better results in the next few years.

Fan et al. (2006) studied the release of CH_4 and CO_2 due to solid waste. In 2014, the U.N. climate summit study revealed that the landfill or disposal of MSW is the primary source of methane gas and eight hundred tons of carbon dioxide in the atmosphere (Lee et al., 2016). It also creates significant health issues for people living near the waste disposal dump yard—limitation of sanitary landfilling results from unskilled labor and lake waste management systems in developing countries. Developed countries' situation is worse because Germany and Japan follow the USA to produce municipal solid waste. Though China was the largest garbage producer in 2004, it surpassed the USA (Li et al., 2016). High population and economic growth countries such as China, India, Japan, and the USA have generated a large proportion of CO2 gas (Nasir & Rehman, 2011).

2.4 Empirical Literature Review.

Moomaw and Unruh (1997) have divided the period into Type I, Type II, & Types III. Type I is the period from 1950 to 1992, Type II is from 1950 to 1972, and Type II is the time from 1973 to 1992. The study used a structural modeling equation to analyze the Environmental Kuznets Curve for 16 countries. The results of type I show the link and relationship between economic growth and carbon emissions. The results of type II show a positive correlation between economic growth and carbon emission, while the effects of type III suggest an irregularity in the relationship between economic growth and carbon emission. The results also confirm the validity of the Environmental Kuznets Curve for ten economies, i.e., there is a positive relationship between economic growth and CO2 emissions at the initial stage but becomes negative after certain threshold limits. The study also found a negative relationship between GDP per capita and carbon emissions at the initial step in 6 economies.

Fan et al. (2006) investigated the anthropogenic factor behind environmental degradation in different countries based on income levels from 1975 to 2000. They found that CO2 emissions result from economic growth at the global level. Countries with a population structure between 15

& 64 and high-income have a negative & most negligible impact on emissions per capita. Environmental degradation is also affected by behavior and fashion. The results also show that per capita emissions are higher in low per capita income countries than in high-income countries. And in upper-income countries, the energy intensity is high and CO2 emissions. Policymakers should consider the population, affluence, and technology (energy intensity) and its impact on CO2 emissions at different economic development levels & in different ways.

Tamazian et al. (2009) examined whether higher economic and financial growth levels contribute to higher per capita emissions in BRIC (Brazil, Russia, Iran, and China) countries. The analysis also covers two more countries, i.e., the USA and Japan, and adds a control variable to the model for robust performance. The relationship between variables is discussed through the Random Effect Model. The results show that the environmental presumption of the Kuznets is retained in the RBIC countries. The study shows that financial liberalization and transparency are the main factors in reducing CO2. The study suggests that policies aimed at economic openness and liberalization to attract a higher level of research and development linked to foreign direct investment could reduce environmental degradation in the countries under consideration. Similarly, the study was also performed by Tamazian et al. 2010; the GMM technique was used to explore the relationship between per capita income, institutional and financial sector growth in environmental quality. The findings of GMM indicate that economic liberalization leads to environmental deterioration and that good institutional efficiency is not achieved.

Baek et al. (2009) noted that Foreign Direct investment plays a critical role in enhancing economic growth through the accumulation of capital technology. They found that the pollution heaven hypothesis holds for India's economy because the increase in the inflow of foreign direct investment led to a decrease or mitigate the environmental quality. Similarly, Liang (2008) found a positive impact of Foreign Direct Investment on air quality in the city. In addition, Acharyya (2009) found a positive effect of foreign direct investment on the pollution level in India. The results suggest a positive and marginal impact in the long run. This indicates that Foreign Direct Investment led to a high level of emissions, confirming the Pollution Heaven Hypothesis.

Fodha and Zaghdoud (2010) estimated the environmental Kuznets Curve for Tunisia using 1961 to 2004. The time series technique has been applied, such as the co-integration technique of Johenson and Juselious (1992). The results confirmed that there exists a long-run relationship between Co_2 emissions and GDP per capita. The results confirm the environmental Kuznets curve for SO_2 while invalid in carbon dioxide emission due to the monotonic solid connection.

Sadorsky (2010) investigated the impact of the financial sector on energy usage for 22 developing countries from 1990 to 2006. The results suggest a positive relationship between stock market variables and energy consumption in these selected 22 developing countries compared to the other financial, developmental variables.

Jalil and Feridun (2011) studied the relationship between financial development and macroeconomic fluctuation for two countries, i.e., Pakistan & China. To capture the long-run relationship, the study utilized the ARDL mode. The results show that there is a high correlation between macroeconomic indicators and financial development. They also found that the growth indicator is highly negatively correlated with financial development. They suggest that both governments should increase financial development; as a result, it will improve the macro-economic fluctuation in the economy.

Boutabba (2014) has analyzed the long-run relationship between financial development, income level, energy consumption, and international trade for the Indian economy from 1971 to 2008. The study utilized the bound test for co-integration and the Granger causality test. According to the bound test, there is a long-run relationship exists among these variables—the increase in financial aid to the private sector led to the rise in CO_2 emissions. Similarly, energy usage is positively associated with CO_2 emissions, but trade is insignificant for India's economy. Also, there is no bidirectional causality from financial development to CO_2 emissions.

Fang and Chang (2016) investigated the impact of energy usage on financial development for seven highly industrialized economies from 1971 to 2010. The study incorporates the Hacker-Hatemi Granger Causality test and found that energy consumption has both a positive and negative impact on Mexico and Malaysia's economies. Financial development is better for the use of energy sources to dwindle the rate of energy usage.

Raza et al. (2017) examined the Environmental Kuznets Curve for Cardon Dioxide as a proxy of environmental degradation in Iran from 1975 to 2009. The study used the ARDL test for the long-run relationship between financial development, economic development, and C02 emissions. Both variables have the opposite impact on the environment. The increase in financial development leads to improving the environmental quality by reducing CO_2 emissions while achieving sustainable economic growth will highly mitigate the environment, which will increase the CO_2 volume.

Hervieux and Darné (2013) analyzed the Environmental Kuznets Curve for Ecological footprint considered a comprehensive proxy for environmental degradation for 7 Latin American countries from 1961 to 2007. The results suggest a linear relationship between ecological footprint and economic growth and confirm that there is no environmental Kuznets Curve hold for Latin American countries. They also test the long-run co-integration among the variables for only two countries, i.e., Brazil and Uruguay. The results suggest that the government should make reforms in environmental policy for long-term benefit and beneficial for the health of the ecosystem.

Lorente and Álvarez-Herranz (2016) examined the correlation between per capita emissions and economic growth by integrating additional variables in the energy regulation model. The research covered 17 OECD countries from 1990 to 2012. The two-stage instrument variable technique results support the N-shape trend between per capita income and economic development. It indicates that creativity and growth in energy regulation minimize social costs and increase the environment's efficiency. They concluded that environmental quality could not improve with increased GDP per capita and that pollution would not immediately vanish with economic performance. Environmental policy and policymakers should also rely on research and development in the energy sector to resolve environmental concerns.

Zhang & Zhou (2016) have investigated the impact of Foreign Direct investment and emission levels in 29 provinces of China. The results of the FE model showed that there is a negative relationship between Foreign Direct Investment and emission levels in China.

Siddique (2017) analyzed the relationship between FD and Cardon Dioxide emissions in Pakistan from 1980 to 2015. The finding showed a highly significant association between FD and C02 emissions, while the short-run relationship is insignificant in the case of Pakistan. Similarly, different unit root tests were utilized and found co-integration between CO_2 and financial development in the United Arabi Emerita (Charfeddine & Khediri, 2016). Also, Sebri and Ben-Salha (2014) used the GMM-SYS technique, co-integration test to find the impact of FD on environmental degradation. Their finding of all models showed that FD has a highly negative impact on the environment, which means FD encourages or promotes environmental quality and further improvement is only possible through financial reform. On the other hand, FD happened at the expense of environmental degradation in the Turkish economy (Cetin & Ecevit, 2017).

Balsalobre-Lorente et al. (2018) used the PLS model (Panel Least Square) to estimate the relationship between economic development, renewable energy use, availability of natural resources, and CO2 emissions. The N-Shape Environmental Kuznets Curve has been verified by empiric estimation in 5 E.U. countries. Countries with higher natural resources also negatively contribute to per capita emissions to reduce their fossil fuel imports. The European Union countries set the target of achieving a 29 percent in renewable energy and emissions at the end of 2020. And by 2050, greenhouse gas emissions will be limited to 80 percent.

Bano et al. (2018) have studied that the growing trend in CO2 emissions is a severe problem for the world. The research used the ARDL and VEM models to examine the short-and long-term relationship between human resources, economic development, and CO2 emissions in Pakistan from 1971 to 2014. Evidence indicates that the most significant and negative impact of human resources on pollution is that as CO2 emissions rise, Pakistan's economic growth increases. A considerable volume of carbon-intensive energy is being used to carry out economic activities in various Pakistan sectors. In the short run, the relationship between human resources and per capita emissions is negligible. In the short run, the relationship between human resources and per capita emissions is insignificant. If human resources, i.e., secondary education and average school enrolment, rise, then CO2 emissions will decrease in Pakistan. If human capital is more educated, it will increase production and services through fuel-efficient technology, training, and skilled labor, resulting in reducing environmental degradation. The private and public sectors' enormous investment in education would promote environmental consciousness among citizens through education.

Found that plastic content presents a significant threat to environmental degradation. An immense amount of single-use plastic is created and dumped on the Earth's surface and cannot quickly degrade naturally. The main objective of the analysis is to present a realistic strategy that helps minimize plastic waste. The literature review procedure was observed between 1997 and 2017. The results show that five fundamental techniques have been pursued, such as land dumping, recycling, incineration, microbial degradation, and conversion into usable material, but they are all minimal.

Ouyang et al. (2019) explored the non-linear impact of environmental regulation / global economic development on air quality. The research used a panel threshold model widely used as a modeling technique to investigate the relationship between environmental regulation and PM 2.5. In contrast to developing countries, an increase in GDP per capita in developed OECD countries could bring growth along with a decrease in PM 2.5 concentrations. The study also states that urbanization & PM 2.5 emissions are inverted to a U-shape in OECD countries. Strict environmental controls and an increase in revenue help reduce public spending to improve air quality. The study concludes that policies that attract people to move to urban areas tend to generate air pollution.

Gorus and Aslan (2019) used the Padroni & Dumitrescu-Hurlin non-causality test to connect and guide the causality of economic growth variables such as GDP per capita, FDI, energy use, and per capita emissions. The research covers the usage of a panel of 9 MENA countries and from 1980 to 2013. It is calculated that the U-shape curve is inconsistent in a few MENA countries such as Algeria, Egypt, Sudan, and Turkey. Energy use is the most polluting determinant of pollution levels in most countries. These findings support the view that the inflow of FDI raises pollution and show evidence of the validity of PHH. The results support the idea of an in-kind donation program to reduce CO2 emissions in the Middle East and North Africa (MME) and to reduce energy usage.

Aldieri et al. (2019) discussed the economic effects of environmentally sustainable innovation, and their awareness of externalities on productivity gained growing attention from the research community. The study points out that information flow is very critical for clean technologies related to pollutants' activities. The results of the survey indicate that public subsidies are not necessary. Still, the policy mix's implementation is more critical if the desired outcome is achieved at the local and national levels. Thirdly, the policy max should include, in particular, a support strategy for cooperation. The environmental sector's innovation activity creates significant knowledge spillovers and positively protects the environment and natural resources.

Ahmed and Wang (2019) show that several empirical influencing factors have been derived for environmental degradation in the literature. Still, this human capital is the main factor in achieving the goal of environmental sustainability. The Bayer and Hanck cointegration test is applied to examine the relationship between human capital and ecological footprint in India from 1971 to 2014. The human capital that is based on secondary education and returns to education will improve the environmental quality. Unidirectional causality exists between these two variables from human capital to the ground. Additionally, energy consumption and increasing pressure of the urban population deteriorate the ecological footprint. The u-shape pattern was observed between GDP per capita & environmental footprint, and human capital can reduce ecological footprint issues.

Majeed and Luni (2019) looked at the empirical relationship between renewable energy use, groundwater withdrawal, and global economic development with the environment. The research uses a panel data methodology and records findings from 166 countries from 1990 to 2017. The release of CO2 is the proxy for environmental degradation. The results support the role of renewable energy in environmental mitigation, while water withdrawal contributes to emissions. The sensitivity analysis also shows the validity of the U & N-shape of the Kuznets' environmental curve. The results of the estimation methodology help the primary funding. The study indicates that a significant amount of renewable energy expenditure would further boost the atmosphere's quality since zero emissions.

Wang and Dong (2019) estimated the relationship between non-renewable and renewable energy use, economic development, and urbanization for 14 SSA panel countries from 1990 to 2014. The ecological footprint (E.F.) is used as a proxy for environmental destruction in the SSA countries. Economic development and urbanization have resulted in a rise in energy needs in sub-Saharan Africa. Augmented Mean Group results indicate that E.F. is open to shifts in GDP, non-renewable energy use, positive-elastic urbanization, and negative-elastic renewable energy use. Renewable energy consumption plays a negative role in the E.F., while urbanization has a positive effect. According to the estimation, an increase of 1% in renewable energy usage would reduce the E.F. by 0.33 percent. Simultaneously, an increase of 1% in GDP would raise the E.F. by 0.205 percent. Finally, the study indicates that policymakers in SSA countries combine to improve environmental degradation and strengthen cooperation with an international organization to maintain sustainable growth and the environment.

2.4.1 Spatial Econometric Literature Review.

Rupasingha et al. (2004) used a broader framework to describe the ECC between economic development and harmful pollutant particles in the U.S. The analysis also includes GDP per capita, racial diversity, and other control variables as explanatory variables. The study shows that there is an inverse relationship between population density and per capita emissions. The research supports the Kuznets Curve environmental hypothesis. The amount of pollution in the city is influenced by the racial diversity of the city. Continued income growth does not guarantee continuous improvement in environmental quality. The racial variable is significantly negatively correlated with the percentage of white and positively correlated with black. The estimate's findings indicate a high degree of emissions in urban areas relative to rural areas. Another key result is that the relationship between per capita income and toxic emission measures is "U-shape."

Maddison (2006) shows that many studies have estimated that neighboring countries' anthropogenic activities do not compromise environmental quality. The analysis calculates the environmental curve for 135 countries over the period from 1990 to 1995. The study used C.O., SO2, NO & non-methane VOC as a surrogate vector for environmental degradation. Instead, there is a process by which emissions change is transmitted to neighboring countries. The research also contains four spatial matrixes for comparison. For the HELSINKI and SOFIA protocols, two dummy variables have been used to whether or not the government has signed the protocol. The findings indicate that per capita emissions are declining by proximity to high GDP per capita and improving environmental quality at neighboring countries' expense. The results suggest that having a high-income neighbor state is correlated with lower NO emissions per capita.

Wang et al. (2013) have demonstrated that, at the global level, the ecological footprint of production and consumption is strongly interrelated. The conventional OLS methodology leads to bias and a selection of an incorrect model for estimation. This research's main objective is to find a pattern between economic growth and the EFP (both consumption and production) as a proxy for global environmental degradation. The spatial econometric technique provides more explanatory capacity than the classical OLS models. The spatial econometric approach examines the research issue as to whether or not the neighboring countries' actions impact the environment. They identified that the consumption and production activities, per capita income, and home country's biocapacity substantially moved the neighboring countries' EFP of consumption and production. Several possible variables, such as trade liberalization, the inflow of FDI, and environmental policies, lead to spatial dependence. There is no statistically relevant support for the inverted "U-shape" EKC for an ecological footprint measure (both production and consumption). The study also shows that the home country's income affects the EFP of consumption while the biocapacity is associated with the EFP of output.

For the first time in China, Hao et al. (2016) investigated the presence of EKC for per capita coal consumption. The research covered 29 provinces from 1995 to 2012. They argue that the traditional estimation method's results ignore spatial dependence and are vulnerable to bias estimation. For this, the study used the Spatial Durbin Model to control spatial dependence between provinces. The Durbin Model also integrates the features of SEM & SLM. There is clear evidence of the "Inverted U-shaped" relationship between per capita coal consumption and per capita GDP in these provinces. The results of the SDM suggest that a turning point for the use of coal will not be achieved in the future. Chinese policymakers should reflect on and prepare for energy use and GHS reduction in the future.

Liu et al. (2018) have shown that environmental sustainability has a remarkable effect on economic growth and human health. The study calculated the spatial impact of FDI inflows and environmental emissions using global and local autocorrelation measures. They have discovered that waste, waste soot, dust, and Sulphur dioxide have taken on quite a different spatial pattern. They concluded that cities in the L.H. category would effectively boost the local community's efficiency by stimulating the surrounding towns through a contact and compensation system. That is why cities with high environmental quality will promote the overall quality of the environment. Cities in the H.L. group need to benefit from the experiences of the surrounding cities. Industry and technologies must be implemented to enhance local environmental quality. The industrial system was established to have a statistically negligible impact on soot, dust, and waste, significantly influencing Sulphur dioxide levels.

Zhao et al. (2019) examined the effect of energy use and financial developments on emissions of SO2 in 30 countries in China. The main objective was to classify the ECC for energy use and environmental pollution from 1999 to 2017. A spatial econometric approach, which shows an increase in environmental emissions, is due to energy usage. The two different proxy types, i.e., financial depth and quality, are used to calculate economic developments. The creation of a financial center has minimized the emission of SO2 and solid waste. Spatial agglomeration effects are essential for the emission of all three forms of pollution in 30 Chinese provinces. The "N-shape" pattern is well supported by Sulphur dioxide and municipal solid waste. The central and local governments must develop strategies to harmonize and manage the reduction of emissions.

Li et al. (2019) used space econometrics to detect the spillover of financial results to the environment. Besides, the study also defines EKC by using data from 30 Chinese provinces from 1995 to 2016. The study used CIWB (Carbon Intensity of Human Well-Being) as a proxy for environmental quality. In the run-up to industrialization and modernization, CWIB decreased with economic growth. As economic growth rises from low to moderate CWIB, it gradually hits a turning point. The study notes the presence of the N-shape EKC. Besides, the rise in economic growth contributes to an increase in/high life expectancy but rises in pollution due to economic development. After the CO2 emission peak around 2030, the second turning point is expected to be reached. It suggests that, in the long run, growth has a positive impact on improving sustainability. Simultaneously, before the second turning point, environmental policies are required to compensate for unintended environmental damage. This study indicated that the overall preparation of industrial and corporate transfers between the provinces would help to protect China's regional environmental issues.

2.5 Summary

Environmental degradation is not a local issue, but it is a geographic issue, and mostly the developing nation is badly affected. The developing countries are highly dependent on fossil fuels, and cheap ways of producing electricity result in high emission levels, and other environmental problems arise. Most of the studies have focused on the Environmental Kuznets Curve, Pollution Heaven, and Hallo Hypothesis using time series and panel data. The current study has used the spatial econometric technique that captures both spatial and spillover effects to identify that environment is not only affected by anthropogenic activities of the host nation but also affects the neighboring nation. The panel and time-series data ignore the spatial dependence and spillover effect.

Chapter 3

QUALITATIVE ASSESSMENT

3.1 Introduction.

The international community has a limited amount of time to address global warming issues. Environmental scientists have warned the global community that the earth's temperature is rising and must be kept below 1.5 degrees Celsius. According to Lord Stern's report (2006), maintaining the world temperature below 1.5 C would cost around 1% of the annual GDP, but ignoring the environmental degradation would cost approximately 20% of the annual GDP by 2050. At the same time, some countries have already crossed the threshold limit of 2 degrees Celsius and created problems for their surrounding economies because of catastrophic and irreversible damage.

Pakistan established the Pakistan Environmental Protection Council in 1984 and made several constitutional amendments in the reconstituted 1997 legislation. The PEPC's primary goal is to keep the sustainable environment while also achieving the Sustainable Development Goals and reducing pollution. Furthermore, Pakistan signed the Paris Agreement in 2015 to achieve the global goal of 2 degrees Celsius or higher to limit global warming to pre-industrial levels by 2050. We are off the road because the earth's temperature is expected to increase by 1.5 C or more in the next decade.

I have interviewed in the concerned department of climate change "**Ministry of Climate Change**" and "**Environmental Protection Agency**." The discussion was based on the following questions.

3.2 Discussion Question.

- How much loss does Pakistan have bear due to Environmental degradation?
- What are the leading causes of environmental degradation in Pakistan?

- What role does FDI play? Shouldn't it be the duty of the Government of Pakistan to put effort into finding and channeling in the environmentally friendly project?
- What is the role of developing nations to attain sustainable development goals and reduce environmental degradation?
- What role is a developed nation playing in exerting the Environmental degradation losses?
- What are the hurdles that stop developing countries from designing standard environmental policies?

3.2.1 Responses.

Pakistan is included in the top 10 countries listed that are highly vulnerable to climate change. Pakistan is facing a loss of 0.53% per unit of GDP due to continuous environmental degradation, and economic loss is estimated at around $ 3792.53 million between 1990 to 2018. Environmental degradation is expected to have far-reaching consequences in Pakistan, including a decrease in agricultural output, contamination of ground water, loss of coastal regions due to sea-level rise, and an increase in the frequency of extreme weather events.

Pakistan is in a stage of development in which industrial and service sector activities are increasing daily, increasing energy demand. Conventional energy, fossil fuels, and renewable energy meet most energy demand, but the share of renewable energy is too low, at 1.1% in 2018. In Pakistan, mainly the transportation sectors and the production of electricity from fuel are the primary sources of air pollution. The degradation of the environment jeopardizes environmental sustainability and threatens Pakistan's ability to cope with poverty and generate a substantial percentage of its development and jobs. The G7 countries have recently taken steps to halt or reduce international funding for high-emission projects such as coal power plants and other polluting industries.

However, Pakistan is still building massive coal power plants such as the Nandipur power project and the Sahiwal power plant. China is investing heavily in coal projects in the Thar region as part of the China-Pakistan Economic Corridor (CPEC), which is the primary source of emissions. In addition, China is the world's largest investor in coal power plants. Out of $64 billion, approximately $34 billion will be invested in the power sector's production and distribution. Developing countries such as Pakistan, India, and others constantly struggle to meet sustainable development goals while experiencing low economic growth.

The federal & provincial governments, along with the help of private environmental protection agencies and NGOs, have taken several initiatives regarding environmental issues. The industrial sector, such as 359 polluting industrial units in Lahore, contributes a lot to greenhouse gases. These industrial units are now being watched. Furthermore, 33% of the brick kilns are converted to zigzag and are bound to adopt zigzag technology as soon as possible. However, the high cost of zigzag technology is regarded as the main impediment to its widespread adoption. The Pakistani government is planning to introduced electric vehicles to counter the problem of CO_2 emission.

To attain the objective of sustainable development goals without stimulating the ecological footprint. Human capital is considered an essential element that helps the economy enhance economic growth and improve the quality of the environment. The government of Pakistan should prioritize human capital indicators, such as education levels and health conditions because they not only play an essential role in the efficient utilization of natural resources through the adoption of advanced environmentally friendly technology but also in the negative impact on the environment in the form of ecological footprint and CO_2. Last but not least, the improvement in human capital will help alleviate poverty and enhance awareness among people about environmental degradation.

Climate change is a geographic issue that the actions of a single country cannot solve. Therefore, the global community should take urgent action, not only for the sake of the current generation but also for the future generation. Developing countries should not only expand but also strengthen their international cooperation. The G7 nations have announced/promised a massive amount of financial aid to developing countries to combat climate change and shift away from fossil fuels. The international community provided funding in 2009 to move emerging nations toward renewable energy uses such as wind, solar, and other power. But these funds are given as loans rather than aid, making it difficult for the poor to use such a low return. Most developed and industrialized nations have taken steps to decarbonize, most notably in the electrical and transportation sectors. Such a step should be taken by developing countries like Pakistan, India & Bangladesh, but it would not be possible without international funding. The first stage is to better understand current pollution levels and sources by re-establishing the monitoring network, which includes equipment and processes, analytic capability, and technical, institutional, and financial sustainability. Authorities must first better understand current levels of pollution, concentrations, trends, and sources to create an effective Action Plan to Reduce Pollution; the terrible environmental state and imminent climate change may also be turned into a growth opportunity for Pakistan in uncovering economic opportunities. The only way to balance investments and avoid high social and healthcare costs is to make them more environmentally friendly from the start.

Yes, environmental degradation is not an issue of one nation but is a geographic issue. They should mostly mimic each other and not degrade environmental degradation by constantly assessing policies against neighboring countries to reduce the cost of policy decisions. But the home nation provides incentives to the industrial sector to achieve sustainable growth and reduce the cost of decision-making prevent them in making common environmental policies in the region.

Chapter 4

DATA & METHODOLOGY

4.1 Introduction.

This chapter focuses on the theoretical framework, econometric framework, the data description, and the variables' measurement. For achieving the research objective, effective spatial econometric methods will be used to estimate the relationship between the dependent and independent variables to accomplish the research objective.

4.2 Theoretical Framework.

In this part of the chapter, the current study has assessed the possible theoretical channels and linked them with all explanatory variables which can influence environmental degradation.

The environment is affected by factors such as an identifiable element in the physical, political, economic, demographic, and technological environment. Lower environmental quality is the dilemma in many less developed countries. The developed countries provide foreign aid to the developing countries for development, growth, and welfare purposes. Sometimes, foreign aid is supposed to be a curse for the environment because its worse impacts are found on the economy (Ramayah et al., 2012). But on the other hand, some studies showed that foreign aid improves the environmental quality if donated only for environmental protection (Chao & Yu, 1999). Tied aid provided by the donors reduces the emissions in the recipient countries, by assumption, the main motive of tied aid implication is pollution abatement. Government stability is also a good measure to get rid of environmental problems because environmental degradation is not at district or city level issue; these issues are faced by the supranational aspects that can disturb all fields like political, economic, social, and human life as well (Sakhaee-Pour & Bryant, 2012). Markets are inconclusive in the pricing of environmental goods; this market failure demands the government's intervention. If the political situation is stable, then such policies can be introduced, which can be helpful to improve environmental conditions. FDI and environmental degradation is a two-way process. Foreign Direct Investment affects welfare positively and negatively; indirectly, it has deleterious impacts on the environment (Bhavan et al., 2011). If examined in developing countries, FDI is another economic variable that becomes evident that plays a vital role in enhancing economic growth and creating awareness about environmental protection.

But on the other hand, transferring the dirty FDI outflows in developing countries is the welfare loss by developed countries, which is the negative effect of FDI inflows in LDCs. This is due to harmful environmental laws in developing countries. In Indonesia, FDI has negative and significant impacts on environment, in industrial sectors FDI introduced the environmentally friendly technologies which reduces the pollution level. Positive and significant impacts showed after increasing the FDI inflows in Mexico, BOD (biochemical oxygen demand) emissions were increased (Hassaballa, 2013).

4.3 Econometric Framework.

This analysis will use the following model to check the linear-quadratic relationship between Ecological Footprint and the economic growth factors.

$$\begin{aligned} \ln EFP_{it} = \beta_0 + \beta_1\left(\ln GDP_{it}\right) + \beta_2\left(\ln GDP_{it}\right)^2 + \beta_3(\ln FDI_{it}) + \\ \beta_4\left(\ln FDI_{it}\right)^2 + \beta_5\left(\ln EC_{it}\right) + \beta_6\left(\ln HC_{it}\right) + \beta_6\left(\ln U_{it}\right) + \varepsilon_{it} \end{aligned} \quad [4.1]$$

In equation (4.1), the natural log is used on both the dependent and the independent sides to make it unit-free and reduce the data variance and the heteroscedasticity problem. Here, β_0 is the constant term, β_i is the explanatory variable's co-efficient, EFP is the Ecological Footprint (a proxy of environmental degradation). The GDP per capita is the proxy of economic growth, E.C. is the energy consumption, FDI is the foreign direct investment, H.C. is the human capital, and ε is the error term. In this equation, the words (lnGDPit) and (lnGDPit)^^{2} are introduced to test the Environmental Kuznets Curve. If the expected value of $\beta_1 > 0$ & $\beta_2 < 0$ is accurate, the U-shape inverted relationship between EFP and economic growth will be confirmed. Besides, the FDI concept is introduced to verify the validity of the Population Heaven Hypothesis. If the expected value of $\beta_4 > 0$, then PHH holds. The co-efficient of energy consumption have positive and the co-efficient of human resources are also projected to be negative. The variable urbanization will be used as a control variable in this study.

4.4 Spatial Econometric Methodology.

The spatial econometric technique has a different benefit. It shows spatial interaction between different demographic areas, appropriately visualizes spatial information, and deal with heterogeneity problems among variables that other techniques do not consider (Abdo et al., 2020). It also helps the researcher focus on spatial diffusion and captures the spatial spillover effect of exogenous variables in the model (Jiang et al., 2018). It also captures the model's dependent variable's spatial and temporal impact (Liu & Wang, 2017). This approach also allows for dynamic and efficiently manages potential spatial correlation, while spatial dependency provides accurate and reliable results (Elhorst, 2014; Reinhard & Linderhof, 2013). According to Elhorst (2003), three types of estimation techniques are used in the Spatial Econometric Model, i.e., SLM, SEM & SDM.

4.4.1 Moran’s I Test.

The Moran's I test will be used to verify whether or not there is spatial dependence. The Moran's I value ranges from -1 to +1. The positive value (Moran's I > 0) indicates the positive spatial dependence, and the higher value of Moran's I (close to +1) indicates a higher positive spatial dependence. While the lower value (Moran's I < 0) indicates weak negative spatial dependency, and the higher negative Moran's I value (close to -1) indicates stronger negative spatial dependence or spatial autocorrelation. If Moran's I test value is equal to or close to 0, it shows no spatial dependency (insignificant). In this study, the Moran's I test will calculate the degree of spatial dependence of the Ecological Footprint. The formula for calculating the Moran's I value is given below,

$$\text{Moran's I} = \frac{n\sum_{i=1}^{n}\sum_{j=1}^{n}W_{ij}\left(X_i - \bar{X}\right)\left(X_j - \bar{X}\right)}{\sum_{i=1}^{n}\left(X_i - \bar{X}\right)^2\sum_{i=1}^{n}\sum_{j=1}^{n}W_{ij}} \qquad [4.2]$$

Here N is the number of observations of the area of ith, and X stands for the variable of interest. The X bar is the average value of variable X, W is the weighted matrices dependent on or built on the distance or border between neighboring countries.

After verifying spatial dependence, the most suitable spatial econometric model will be used to discuss spatial dependence. The critical difference between these two models is how spatial dependency is implemented into the regression model.

4.4.2 General Form of Spatial Lag Model.

$$Y = \alpha + \rho WY + \beta X + \varepsilon \qquad [4.3]$$

In the regression equation, the concept of spatial autocorrelation refers to the situation where the endogenous variable's value at one location depends on the value of observation at another location (Asgharian et al., 2013). In a spatial regression model, the shock in the independent and error term at one location is transmitted to another site in the case of SLM (LeSage & Pace, 2009). In this equation, the Y represents the dependent variable, X represents the independent variable's matrix, W represents the weighted spatial matrix. The coefficient β represents the co-efficient of the explanatory variable, α are scalar parameter, ρ represent the co-efficient of spatial autoregression, and ε is the error term. By substituting the value of equation (4.1) into equation (4.3) then we get the desired equation of the Spatial Lag Model are,

SLM are,

$$\ln EFP_{it} = \alpha_i + \rho \sum_{j=1}^{n} W_{ij} EFP_{it} + \beta_1 \left(\ln GDP_{it}\right) + \beta_2 \left(\ln GDP_{it}\right)^2 + + \beta_3 \left(\ln FDI_{it}\right) + \beta_4 (\ln FD1_{it})^2 + \beta_5 \left(\ln EC_{it}\right) + \beta_6 \left(\ln HC_{it}\right) + \beta_7 \left(\ln U_{it}\right) + \varepsilon_{it} \quad [4.4]$$

The symbol's meaning in the above equation is the same as explained in the equation [4.1] & [4.3].

4.4.3 General Form of Spatial Error Model.

Another way to integrate spatial dependency is via the Spatial Error Model. The error term associated with any observation is a spatially weighted average of the error term at neighboring locations plus a random error variable.

$$\begin{aligned} Y &= \alpha + \beta X + \varepsilon \\ \varepsilon &= \lambda W \varepsilon + \upsilon \end{aligned} \quad [4.5]$$

In SEM, the only shock in the error term at one location is transmitted to another site in the spatial system (LeSage & Pace, 2009). In equation [4.4], ρ represents the co-efficient of spatial regression, and ε is the spatial error term. By substituting the value of equation [4.1] in equation [4.5] then we get the desired equation of the Spatial Error Model is,

SEM are,

$$\ln EFP_{it} = \alpha_i + \beta_1\left(\ln GDP_{it}\right) + \beta_2\left(\ln GDP_{it}\right)^2 + \beta_3\left(\ln FDI_{it}\right) + \beta_4(\ln FDI_{it})^2 + \beta_5\left(\ln EC_{it}\right) + \beta_6\left(\ln HC_{it}\right) + \beta_7\left(\ln U_{it}\right) + \varepsilon_{it} \quad [4.6]$$

$$\varepsilon_{it} = \lambda\sum_{i=1}^{n} W_{ij}\varepsilon_{jt} + \upsilon_{it} \quad [4.7]$$

The meaning of the above symbol in the equation is the same as explained in the equation [4.1], [4.3], & [4.4].

4.4.4 General Form of Spatial Durban Model.

LeSage and Pace (2009) suggest a Spatial Durbin Model improves the Log-Likelihood ratio of the Spatial Error model. It often integrates the exogenous and endogenous variable's spatial lag value as an explanatory variable affecting the dependent variable in the model. It also nests the characteristics of both SLM and SEM.

$$Y = \alpha + \rho WY + \theta WX + \beta X + \varepsilon \quad [4.8]$$

In equation [4.8], θ represents the spatial lag term of the independent variable and shows the initial lag independent variable's impact. By substituting the value of equation [4.1] in equation [4.8], then we get the desired equation of the Spatial Durbin Model are,

SDM are,

$$\ln EFP_{it} = \alpha_i + \rho\sum_{j=1}^{n} W_{ij} EFP_{it} + \beta_1\left(\ln GDP_{it}\right) + \beta_2\left(\ln GDP_{it}\right)^2 + \beta_3\left(\ln FDI_{it}\right) + \beta_4(\ln FDI_{it})^2 + \beta_5\left(\ln EC_{it}\right) + \beta_6\left(\ln HC_{it}\right) + \beta_7\left(\ln U_{it}\right) + \theta\sum_{j=1}^{n} W_{ij}\left(\ln GDP_{it}\right) + \theta\sum_{j=1}^{n} W_{ij}\left(\ln FDI_{it}\right) + \theta\sum_{j=1}^{n} W_{ij}\left(\ln EC_{it}\right) + \theta\sum_{j=1}^{n} W_{ij}\left(\ln HC_{it}\right) + \theta\sum_{j=1}^{n} W_{ij}\left(\ln U_{it}\right) + \varepsilon_{it} \quad [4.9]$$

The meaning of the symbol is the same as explained in the equation [4.1], [4.2], & [4.4].

4.4.5 Spatial Weighted Matrix.

Several spatial weighted matrices are constructed in literature, but two types of weighted matrices are built-in most research. The first is based on the contiguity criteria under which the nation shares its boundary with neighboring countries. The second is dependent on size if the distance between their centroids is less than the threshold, such as 1750 (Maddison, 2006). In this analysis, the weighted spatial matrix will be based on contiguity.

$$\begin{pmatrix} 0 & 1 & 1 & 1 \\ 1 & 0 & 0 & 1 \\ 1 & 0 & 0 & 1 \\ 1 & 1 & 1 & 0 \end{pmatrix} \qquad [4.10]$$

4.4.6 Spillover or Feedback Effect.

The spatial spillover effects that the change in the one variable affects its host nation and the consequence also observe in the surrounding countries. In the spillover effect, multiple effects exist together. According to LeSage and Pace (2009), spillover (direct or indirect) affects the change in area j due to the change in region i. It differs from the regression parameter because direct effects refer to local variables that consider the feedback effect, while indirect effects refer to spillover effects. The general format is seen below,

$$DF^{k} = (I - \lambda W)^{-1}(\theta_{k} I) \qquad [4.11]$$

$$IDF^{k} = (I - \lambda W)^{-1}(\delta_{k} W) \qquad [4.12]$$

$$TF^{k} = (I - \lambda W)^{-1}(\theta_{k} I + \delta W) \qquad [4.13]$$

The DF in the preceding equation represents the direct effect, the IDF represents the indirect influence, and the TF represents the overall effect of the kth explanatory and control variable.

4.5 Sources of the Data.

The annual data of 25 Asian countries have been used in this analysis from 1990 to 2017. The dependent variable data, i.e., Ecological Footprint, would be taken from the Global Ecological Footprint Network. Similarly, data on independent variables such as economic development, energy use, and foreign direct investment will be obtained from the World Development Indicator (WDI). Human capital data would be amassed from WDI, but it is not accurate for estimation due to the missing value. Therefore, human capital data will be obtained from the Penn World Table 9.0, the more precise data source (Feenstra et al., 2015)[4].

Table 4.1: Countries List

No	***Countries***	***No***	***Countries***
1	*Armenia*	*14*	*Nepal*
2	*Bahrain*	*15*	*Pakistan*
3	*Bangladesh*	*16*	*Philippines*
4	*China*	*17*	*Qatar*
5	*India*	*18*	*Saudi Arabia*
6	*Indonesia*	*19*	*Singapore*
7	*Israel*	*20*	*Sirlank*
8	*Japan*	*21*	*Thailand*

[4] The sample size is reduced due to the availability of Ecological Footprint and human capital data.

9	*Jordan*	*22*	*Turkey*
10	*Kazakhstan*	*23*	*United Arab Emirates*
11	*Kuwait*	*24*	*Viet Nam*
12	*Malaysia*	*25*	*Yemen*
13	*Myanmar*		

4.6 Definition of Variable.

Table 4.2: **Definition of Variable**

Variable	**Definition**	**Measurement**	**Sources**
Ecological Footprint	Index of six land base categories given below	Hectares per capita	Global Ecological Footprint Network
Economic Growth	GDP per capita is the gross domestic product divided by the mid-year population	Constant 2010 US $	World Development Indicator (2018)
Foreign Direct Investment	Net inflows from foreign country investors in the host economy and divided by GDP	% Of GDP	World Development Indicator (2018)
Energy Consumption	Use of primary energy before conversion to other end-use fuels	Kg of oil equivalent per capita	World Development Indicators (2018)

Human Capital	Index of human capital is based on the average educational year and expected outcome	index	Penn World Table Version 9.0
Urbanization	The urban population is a proportion of the overall population.	% Of Total Population	World Development Indicator (2018)

4.6.1 Dependent Variable.

- **Environmental Degradation.**

Wackernagel and Rees (1998) were the first to introduce the concept of ecological footprint. In this study, the Ecological Foot Print has been used as a proxy for environmental degradation. It is the index of six land base categories, i.e., land for the production of crops, land for cattle, land for primary production and harvesting of marine animals, land for forestry, land for the absorption of CO_2 emissions, and land for infrastructure (Global Ecological Footprint Network). In this analysis, the ecological footprint will be measure in Hectares per capita.

4.6.2 Independent Variable.

- **Economic Growth.**

GDP per capita is the gross domestic product divided by the mid-year population. It entails the depreciation of assets and the deterioration and degradation of natural resources. The GDP per capita has been used as a measure of per capita output. It is measure in Constant 2010 U.S. $ (WDI, 2018).

- **Energy Consumption.**

Energy usage means using primary energy before transformation into other end-use combustibles, equal to indigenous production, plus import and inventory adjustments less—measurement per capita in kg of oil equivalent (WDI, 2018).

- **Foreign Direct Investment.**

This graph depicts net inflows from foreign investors into the host economy, which GDP then splits. The net investment inflows for acquiring long-term management interest (10 percent or more of the voting shares in a firm operating in a country other than the investors) are shown in Foreign Direct Investment. The balance of payments shows the amount of equity capital, dividend reinvestment, extra long-term capital, and short-term capital. It is a measure of GDP as a percentage (WDI, 2018).

- **Human Capital.**

Several studies have used the human capital index as a proxy for human capital (Bano et al., 2018; Fang & Chang, 2016). The index of human capital is based on the average educational year and expected outcome.

- **Urbanization (Control Variable).**

Urbanization is used as a control variable in this analysis and measured as % of the total pollution.

4.7 Descriptive Statistics.

Table 4.3 represents the descriptive statistics of all variables used in this study. The descriptive statistics give a detailed overview of the data. The total number of observations is 450, where n = 25 and T = 28.

Table 4.3: Descriptive Statistics.

Variable	*Obs*			*Mean*	*Std.dev*	*Min*	*Max*
	N	*n*	*T*				
EFP	450	25	28	0.959	0.896	-0.605	2.834
GDP	450	25	28	8.617	1.516	5.835	11.152
FDI	450	25	28	3.433	4.501	-2.757	28.598
EC	450	25	28	7.314	1.291	4.963	10.004
HC	450	25	28	0.869	0.249	0.160	1.380
U	450	25	28	3.946	0.545	2.595	4.605

Chapter 5

RESULTS & DISCUSSION

5.1 Introduction.

In this chapter, we empirically analyze the different spatial econometrics models using the spatial panel data that explain the effect of economic performance on Ecological Footprint in Asian Countries (from 1990 to 2017). The dependent variable is Ecological Footprint, and explanatory variables are per capita income, inflow of FDI, Energy consumption, human capital & Control variable. All variables are in log form, so our specified SEM is equation (4.6). We can convert to non-spatial models easily by eliminating the spatial interaction effects, with spatial effect or/and period fixed effects.

5.2 Levin Lin & Chu Unit Root Test.

Checking the stationary of the variable in panel data is also, per se, a matter of interest and can be more directly motivated. The time-series behavior of an individual variable should frequently be well approximated as an autoregressive process with a small positive coefficient and large fixed effects, or as an autoregressive process with a near-unit root and negligible individual fixed effects, as we know, within the general class of models in which heterogeneity is limited to an individual fixed effect. Both options can be compared against each other using a root panel data unit test on a single model. However, due to non-observed starting circumstances and inadvertent parameter estimations, such tests are unlikely to function effectively on a short panel. As a result, it is feasible to analyze the characteristics of available tests in a realistic setting. In the literature, the Levin, Lin & Chi unit root test is the most appropriate for checking the stationarity of variables in the case of strongly balanced data. Therefore, the current study utilized the Levin, Lin & chi test for checking that variables are stationary at level or first difference. Table 5.1 shows the Levin, Lin & Chi unit root test results. The null hypothesis of this test is non-stationary (unit root problem), and the alternative hypothesis is stationary (no unit root problem). The variables Ecological Footprint (EFP), Gross Domestic per capita (GDP), Energy consumption (EU), Human Capital (HU), and Urbanization (U) are stationary at the first difference because the p-value is less than 0.05 & 0.01 level of significance (means accepting an alternative hypothesis). While the variable Foreign Direct Investment (FDI) is stationary at level (p-value < 0.05). Hence, there is a mixed order of integration. A few variables are in the order of I (0), and a few are in I (1).

Table 5.1: Levin, Lin & Chu Unit Root Test

Variable	Lag	Level	First-Diff	Decision
LnEFP	(2)	0.294	-13.420 ***	I (1)
P-value		0.616	0.000	
LnGDP	(2)	18.422	-8.106 ***	I (1)
		1.000	0.000	
LnGDP^2	(2)	18.530	-8.270 ***	I (1)
		1.000	0.000	
LnFDI	(2)	-3.178 **		I (0)
		0.031		
LnFDI^2	(2)	-5.447 **		I (0)
		0.029		
LnEC	(2)	4.680	-16.661 ***	I (1)
		1.000	0.003	
LnHC	(2)	1.923	-1.788 **	I (1)
		0.973	0.000	
LnU	(2)	2.762	-1.012 ***	I (1)
		0.977	0.000	

**** p<.01, Significant at 1 %*

*** p<.05, Significant at 5 %*

** p<.1, Significant at 10 %*

5.3 Spatial Dependence Test.

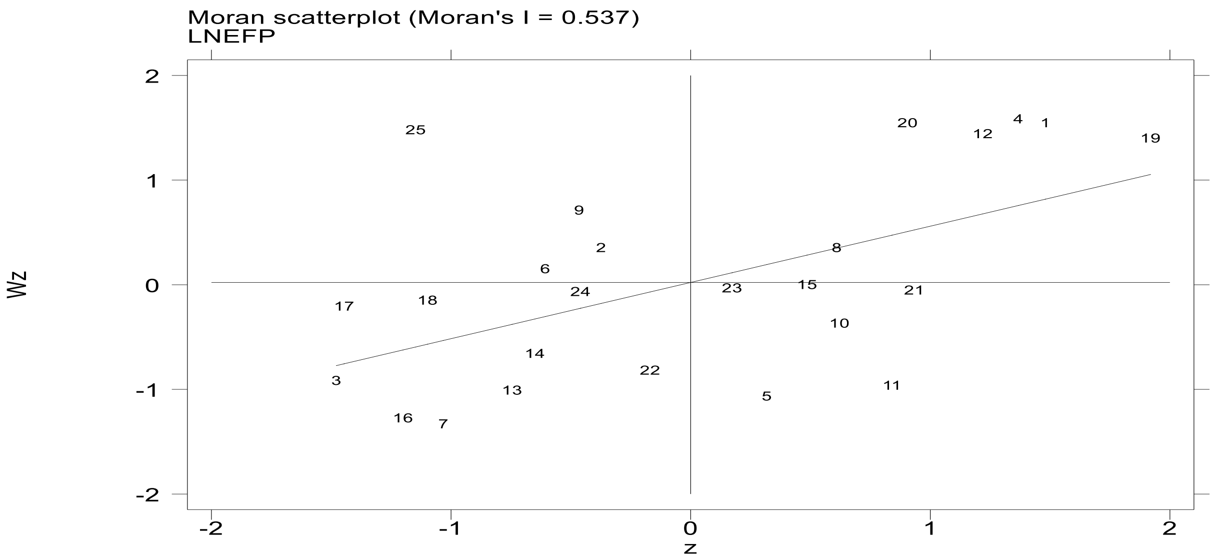
Maddison (2006) used Moran's I and Geary's C tests to look for spatial dependence or autocorrelation; the Moran's I test is mainly used for testing spatial dependence (Abdo et al., 2020; Hao & Liu, 2016; Li et al., 2019). Therefore, this study has utilized the Moran's I test for detecting spatial dependence, and the results are given in Table 5.2. The results show that Geary's C statistic is highly significant for all variables (except EC) at the 1% significance level. Furthermore, Moran's I statistical value is positive and highly significant at a 1% significance level. The positive sign indicates that there is a positive spatial dependence. Furthermore, it is also confirmed by Figure 4.1 of Moran's I test that most of the values lie in the upper right quadrant and lower left quadrant, indicating positive spatial dependence. The Moran's I statistic, i.e., 0.27, shows positive spatial dependence and demonstrates that a highly polluted nation has more significant influence and pollutes its neighboring nations because a highly polluted nation surrounds it.

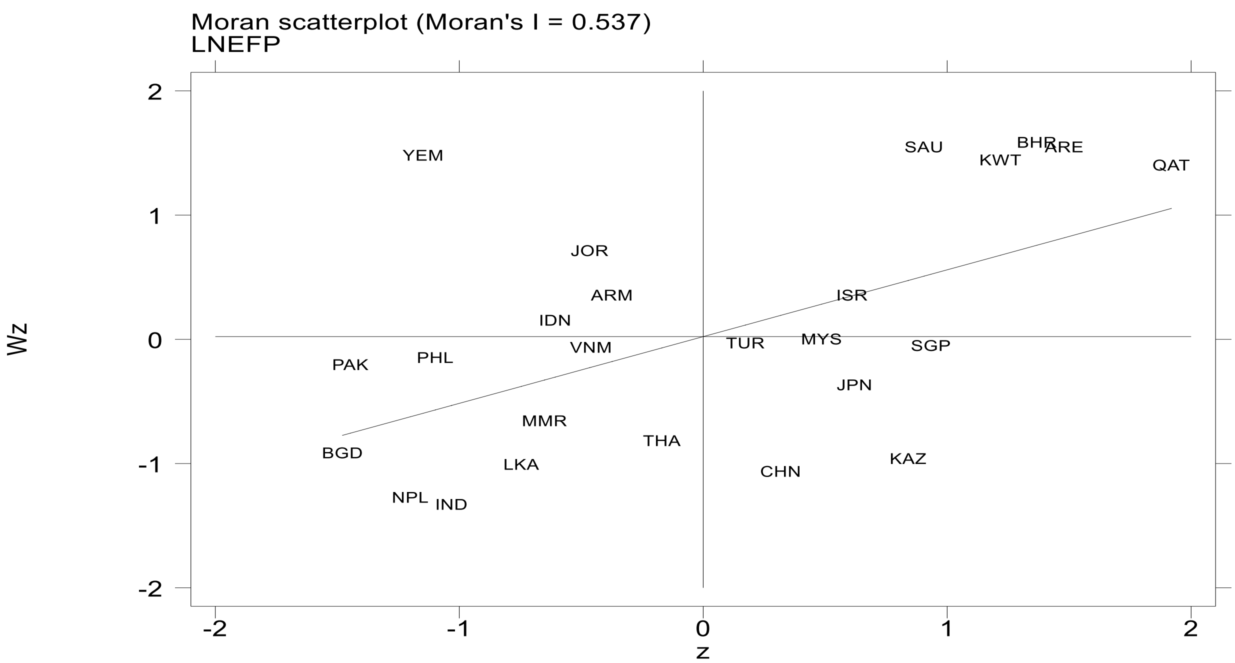
Table 5.2: Moran's I Test.

	Moran's, I Test		**Geary's**	
Variable	I	P-value	c	P-value
LnEFP	0.537	0.000	0.556	0.001
LnGDP	0.466	0.000	0.601	0.003
LnFDI	0.538	0.000	0.561	0.001
LnEC	-0.028	0.332	0.834	0.299
LnHC	0.143	0.086	0.748	0.047
LnU	0.611	0.000	0.407	0.000
Moran's I Statistic	***Moran's***	***P-value***		
	0.466	0.000		

**** p<.01, Significant at 1 %*
*** p<.05, Significant at 5 %*
** p<.1, Significant at 10 %*

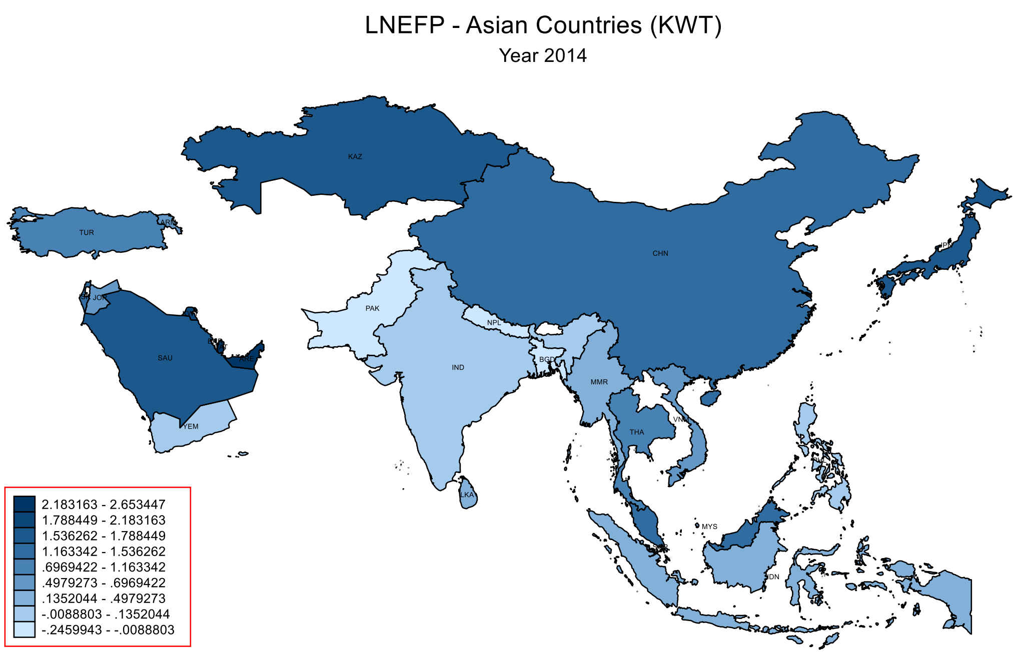
Figure 5.1: **Moran Scatterplot.**





The map (5.1) indicates that countries with dark blue are highly polluted and have worse conditions in terms of ecological degradation. These countries are China, Saudi Arabia, Indonesia, Japan, and Kazakhstan are countries having a high rate of ecological footprint mitigation because Saudi Arabia is oil-dependent countries and inflow of FDI inflows into Arab countries have been concentrated in extractive industries which is highly polluted, particularly during the oil boom era, in recent decades (Abdo et al., 2020). Similarly, China (27%) is included in the list of top 5 countries responsible for higher emission levels. China is a highly coal-dependent country to fulfill the energy demand. Japan is the country that has made significant technological progress to reduce the emission level from 5.72 to 3.4 %. But still, it is considered higher level of emission. Furthermore, the ecological footprint (the area of land and water it takes to for human being to generate the renewable resources it consumes) consumption exceeds the domestic biocapacity (it is the capacity of biosphere to regenerate and provide for life) in the above five countries. At the same time, the blue and light blue color represents those countries having a low rate of ecological footprint mitigation but face severe consequences of environmental degradation.

Figure 5.1: **Map.**



5.4 Fixed & Random Effect.

Before implementing a spatial technique on panel data, choosing the optimal panel model among fixed and random models is necessary. Table 5.3 shows the results of panel estimation without considering spatial dependence. In both models, the results show that the GDP co-efficient positively impacts the ecological footprint while its square term has a negative impact. Which also confirms the validity of the Environmental Kuznets Curve. Variable foreign direct investment has positively influenced the ecological footprint, which ensures the Pollution Haven Hypothesis. The above table confirms that all variables are statistically significant at the 5% level of significance. To select the accurate model for further spatial analysis, we used the Hausman test to choose the best model. The Hausman test's Null Hypothesis states that the random model is appropriate, while the Alternative Hypothesis states that the fixed effect model is suitable. The results of the Hausman statistics are highly significant at the 5% level of significance. The results are consistent with Azam et al. (2015); Hao et al. (2016). Another way to choose a model based on rho is if the value of rho shows an interclass correlation. If the Rho value is close to zero, we will use pooled regression; if it is close to one, we will use a fixed-effect model. Therefore, we concluded that the fixed effect model is appropriate for spatial econometric analysis based on Hausman statistics. In the presence of spatial dependence, the results of the fixed effect and random effect models are unreliable for analysis.

Table 5.3: FE & RE:

Variable	Fixed Effect	Random Effect
LnGDP	0.473 *** (0.132)	0.443 *** (0.120)
LnGDP^2	-0.018 *** (0.008)	-0.015 ** (0.008)
LnFDI	0.010 ** (0.003)	0.011 *** (0.001)
LnFDI^2	-0.001 *** (0.001)	-0.001 *** (0.001)
LnEC	0.689 *** (0.052)	0.600 *** (0.048)
LnHC	0.300 *** (0.103)	0.232 ** (0.091)
LnU	-0.550 *** (0.109)	-0.419 *** (0.093)
Rho	0.719 ** (0.046)	0.084 (0.037)
Lgt_theta		-2.079 *** (0.184)
Sigma2_e	0.007 *** (0.001)	0.008 *** (0.001)
R^2	0.936	0.949
Log-Likelihood	461.764	391.959
Hausman Test	*Coef.* 9.508	*P-value* 0.018

**** p<.01, Significant at 1 %*
*** p<.05, Significant at 5 %*
** p<.1, Significant at 10 %*

5.5 Comparison of Model (SLM, SEM & SDM).

We estimate three important models of spatial econometrics, i.e., SAC, SEM & SDM have been estimated with a weighted matrix of contiguity. Anselin (2005); Wang et al. (2013) suggest that the value of R^2 in spatial econometric results is not a real measure of fit, so it is called pseudo-R^2. The proper measure of goodness of fit for the spatial regression model is based on the highest log-likelihood, lower value of Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), and Schwarz Information Criteria (SIC) (Anselin, 2005) & lower value of log-likelihood

Ratio (LLR). Secondly, Elhorst (2012) suggests LM-Test (Lagrangian Multiplier) select the appropriate model among SAC, SEM, and SDM. Based on the below results, the best model is Spatial Error mode because of the lower value of LLR, AIC & BIC (8.68, -926.55, -889.57) and the comparatively higher value of Log-Likelihood, i.e., 466.235. The spatial dependence co-efficient of SEM is positive, i.e., $\lambda = 0.284$, which is significant at the 5% level of significance. The positive sign indicates that a highly polluted nation will negatively affect the environment in the neighboring country, because high pollution in one country basically deteriorate environment in the neighboring country. The results show that the co-efficient of spatial dependence $\rho = -0.205$ (prob-value is less than the 0.05 level of confidence). The negative value of spatial dependence indicates that an improvement in environmental quality will increase the environmental quality of the surrounding nation. While the spatial dependence co-efficient of SEM & SDM is positive, i.e., $\lambda = 0.284, 0.240$ is significant at the 5% level of significance. The positive sign shows that highly polluted surrounding nations influence one country's environment or the environmental degradation in one nation has significantly affected the environment of the neighboring nations.

The co-efficient of GDP & its squared term is highly significant (Prob-value < 0.05) in all models (SAC, SEM & SDM). The results show that at the initial level, the increase in economic growth led to environmental degradation. It shows that an increase in economic growth will cause environmental degradation in neighboring countries. After reaching the optimal level of economic growth, further increases in economic growth will improve the quality of the environment. All three model co-efficient of GDP^2 are highly significant at a 1, 5, and 10% significance level. The results suggest that the square term of GDP has a minor negative impact on the ecological degradation. Hence, there is a non-linear relationship between economic growth and the ecological footprint. Our results are consistent with (Abdouli et al., 2018; Zhu et al., 2016). In other words, after achieving the threshold, a 1% increase in the GDP per capita of one country would spend 0.019 percent on environment sustainability. We found an inverse U-shape curve, which is called the Environmental Kuznets Curve. This means that Asian countries are still far away from their threshold. According to the IMF prediction, it may be achieved after 2030. In the long run, sustainable economic growth leads to a reduction in environmental degradation. To achieve a turning point soon, all countries should accelerate GDP to achieve the turning point.

The relationship between FDI and the ecological footprint demonstrates how FDI inflows into one country positively impact environmental degradation in neighboring countries. The co-efficient of FDI is highly significant in all three models but shows a small portion of the variation in the dependent variable. The positive sign of FDI indicates that an increase in the inflow of foreign direct investment in one nation causes the ecological footprint mitigation. The results suggest that the polluted Heaven hypothesis exists, and the results are supported by Abdo et al. (2020); Rafindadi et al. (2014). These results suggest that most Asian countries are in the developing stage due to leniency in environmental regulation and unplanned inflow of FDI in the polluted incentive sector, which led to the quality and delay in sustainable development goals. Furthermore, developing countries' flexible environmental regulations entice foreign investors to invest in polluting sectors. To achieve the SDGs and repay economic development, these countries should create an environment that encourages foreign investors to invest in a productive sector with low environmental costs, such as wind or solar energy and other sectors. This enhancement and use of environment-friendly technology will help fulfill the energy demand and help achieve the SDG of 2030. Energy consumption positively impacts environmental degradation because the increasing pressure on energy demand due to industrial development is fulfilled by using fossil fuels or other non-renewable energy methods. Asian countries are developing, and their primary goal is to achieve higher economic growth, which results in the emission of harmful gases. According to the findings, an increase in non-renewable energy consumption has resulted in a 0.68 percent increase in ecological footprint degradation. To achieve long-term economic growth and low emissions, the economy should shift toward renewable energy. The advancement & improvement in technology and renewable energy are necessary for the sake of a better future. According to Barry (2011), a small investment is required for the initial setup of renewable energy. The co-efficient of human capital is highly negatively significant at a 1 percent level of significance. The results suggest that environmental degradation can be mitigated by improving human capital. A one-year increase in the education level will result in a 0.27 percent improvement in the ecological footprint. The human capital that is measured by secondary enrollment and the average level of education will create awareness and mitigate the ecological footprint degradation in such a way that we use renewable energy, use recycled products, produce more potential skilled and educated labor, productive labor and help policies to improve environmental quality (Ahmed & Wang, 2019; Wijaya & Tezuka, 2013). We concluded that education is the main reason behind human capital, which will help to reduce pollution. Human capital is abundant in developing countries, and focusing on it will boost economic growth and help reduce pollution. Labor will quickly adopt and use advanced environment-friendly technology and advanced methods of production, which will also help reduce environmental degradation.

Table 5.4: SAC, SEM, & SDM:

Variable	***SAC***	***SEM***	***SDM***
LnGDP	0.590 ***	0.525 ***	0.916 ***
	(0.131)	(0.132)	(0.134)
LnGDP^2	-0.020 **	-0.019 **	-0.032 ***
	(0.008)	(0.008)	(0.008)
LnFDI	0.004 *	0.005 *	0.003
	(0.003)	(0.004)	(0.003)
LnFDI^2	-0.000 ***	-0.006 ***	-0.021 ***
	(0.001)	(0.002)	(0.001)
LnEC	0.649 ***	0.683 ***	0.526 ***
	(0.049)	(0.050)	(0.052)
LnHC	-0.264 ***	-0.275 ***	-0.661 ***
	(0.099)	(0.102)	(0.112)
LnU	-0.278 ***	-0.418 ***	-0.487 ***
	(0.106)	(0.101)	(0.126)
W*LnGDP			0.460 ***
			(0.231)
W*LnGDP^2			-0.019
			(0.014)
W*LnFDI			0.017 ***
			(0.006)
W*LnFDI^2			-0.001
			(0.003)
W*LnEC			-0.258 **
			(0.109)
W*LnHC			0.028
			(0.193)
W*LnU			-1.370 ***
			(0.275)
ρ	-0.205 ***		0.240 ***
	(0.106)		(0.052)
λ		0.284 ***	
		(0.051)	
AIC	-933.229	-926.552	-974.230
BIC	-892.136	-889.569	-908.482
Likelihood Ratio	29.70 ***	8.68 **	82.70 ***
Observation	450	450	450
R^2	0.913	0.944	0.443
Log-Likelihood	464.533	466.235	498.852

**** p<.01, Significant at 1 %*

*** p<.05, Significant at 5 %*

** p<.1, Significant at 10 %*

Table 5.5: Spatial Error Model:

Variable	***Co-efficient***	***Std.dev***
LnGDP	0.525 ***	(0.132)
LnGDP^2	-0.019 **	(0.008)
LnFDI	0.005 *	(0.004)
LnFDI^2	-0.006 ***	(0.002)
LnEC	0.683 ***	(0.050)
LnHC	0.275 ***	(0.102)
LnU	-0.418 ***	(0.101)
R^2	0.94	
Likelihood-Ratio	8.68**	
Log-Likelihood	466.235	
AIC	-926.552	
BIC	-889.569	

**** p<.01, Significant at 1 %*
*** p<.05, Significant at 5 %*
** p<.1, Significant at 10 %*

5.6 Spillover Effect.

In this analysis, we also calculate the direct, indirect, and total effects of the explanatory and control variables in Table 5.6, which is based on (LeSage & Pace, 2009). In table 5.6, all variables in direct, indirect, and total effect are highly significant at 5 percent level of significant, accepted foreign direct investment in the indirect effect, energy consumption, and human capital in the indirect effect. Indirect effect, the GDP per capita and its square term significantly show that environmental degradation increases in the country with economic growth. But with time or after the turning point, the government spent income to protect the environment. The FDI and its square term are insignificant in the indirect effects. The positive direct effect of economic growth and energy consumption imposes additional pressure on the environment degradation. As a result, policymakers should provide subsidies or training for businesses, owners, and households to use renewable energy and inefficiently use their resources to improve environmental quality and, as a result, higher economic growth. As people's lifestyles have improved and 60 % of renewable energy & environmentally friendly technology has been adopted by the end of 2030, the government should launch the project by providing grants in the form of financial subsidies, aid, and investment facilities for foreign and local investors. These actions will contribute to the achievement of the UNDP's Sustainable Development Goals No. 11 (Sustainable Cities and Communities) and No. 13 (Climate Action) (UNDP, 2017). In the indirect effect, a one percent increase in the income per capita of neighboring countries cause environmental degradation in the home country. These results suggest that the neighboring countries' environment strongly influences change in domestic environmental degradation. This shows that a change in environmental performance might result from a change in neighboring nations, implying that surrounding countries cheat each other when they set environmental rules and regulations. The co-efficient of FDI and its square term is highly significant at a 5 % significance level, but the square term proportion is low. Mainly, Asian countries are developing and trying to increase their infrastructure, industries, production, and energy from non-renewable sources such as oil, gas & coal, etc.

Furthermore, every country wants to protect its domestic companies while competing to increase and reduce costs in the international market. Still, they thrive on environmental standards, and weak regulations lead to increased environmental degradation. The government and domestic firms should adopt policies that encourage competition based on innovation in renewable energy and low-emission products. This encouragement will contribute to the achievement of Goal No. 8 (Decent work and economic growth).

Table 5.6: Direct & Indirect Effect:

Variable	***Direct Effect***	***Indirect Effect***	***Total Effect***
LnGDP	0.961 ***	0.843 ***	1.803 ***
	(0.138)	(0.276)	(0.328)
LnGDP^2	-0.034 **	-0.033 **	-0.066 **
	(0.008)	(0.016)	(0.018)
LnFDI	0.004	0.021 ***	0.026 ***
	(0.003)	(0.007)	(0.008)
LnFDI^2	-0.005	-0.001 ***	-0.006 ***
	(0.000)	(0.000)	(0.000)
LnEC	0.523 ***	-0.167	0.356 **
	(0.051)	(0.140)	(0.157)
LnHC	0.678 ***	0.217	0.895 ***
	(0.115)	(0.241)	(0.294)
LnU	-0.581 ***	-1.861 ***	-2.443 ***
	(0.139)	(0.380)	(0.460)

**** p<.01, Significant at 1 %*
*** p<.05, Significant at 5 %*
** p<.1, Significant at 10 %*

Chapter 6

CONCLUSION

6.1 Conclusion.

Researchers can utilize spatial econometric techniques to understand how environmental deterioration is based on the particularities of the countries surrounding a nation. The research studies the effect of economic performance on the ecological footprint for 25 Asian countries between 1990 and 2017. The study incorporates only one control variable in the spatial econometric model. Because of the data availability of the ecological footprint, the analysis has been limited to 25 nations. In this instance, panel data is used in the investigation, and, hence, panel spatial auto-regressive, spatial error model, and spatial Durbin model tests are utilized.

In the sample, there is high spatial dependence among the Asian countries, according to empirical tests such as Moran's I test. The data shows that the spatial error model is the most appropriate for explaining the correlation between the ecological footprint and economic performance. It was found that the spatial dependence coefficient is considerable (λ=0.284 with (0.051)) and positive, which means that the economic activity strongly influences the environmental degradation in one nation in the neighboring nation. Due to the traditional methodology ignoring spatial dependence and yield bias, the parameters become inconsistently dependent on their positions and inaccurate.

Empirical evidence suggests that increased energy demand, as well as a shift toward the service sector, have contributed to an increase in environmental degradation. New technology could not be used at first, and more energy was required. While, over time, the use of new technology, better training, and education leads to faster growth, efficiency increases as it becomes easier to implement advanced technology. The findings support the previously hypothesized inverted U-shaped relationship between emissions per capita and income per capita for Asian countries, which is called the Environmental Kuznets Curve. Further, because renewable energy represents a small fraction of the overall energy market, this relationship is even more meaningful.

Furthermore, the results support the polluted heaven hypothesis. The square term of FDI has a detrimental influence on environmental quality improvement, though its share is minor. These Asian countries are developing, making it challenging to implement the Sustainable Development Goals at their current low growth rate. Because of the variability in economic growth and the desire to attain long-term high economic growth, every growing country provides major incentives for the industrial sector. This industrial sector is mainly dirty and emits harmful fumes. Because of a lack of understanding of environmental degradation, there is an increase in the demand for dirty energy and the high consumption of fossil fuels. In Asian countries, energy is produced in the traditional manner using fossil fuels. These energy sectors are inefficient and have not invented renewable energy methods. The key outcome of this study is that human capital has a positive and considerable impact on the ecological footprint. Most Asian countries have a large population, such as India, Indonesia, and Pakistan, and a large number of young people. The goal of protecting the environment may be improved further by investing in human capital, and the results will observe in the long term. This investment will result in greater innovation, skilled personnel, increased output, and lower hazardous gas emissions. A nation that focuses more on environmental sustainability can be achieved by organizing seminars and raising awareness through education. This will improve environmental quality, help save energy, which is one of the significant sources of energy emissions, and eliminate it by implementing green technology. To enhance the quality of the environment and people's living standards, the government should initiate and participate in renewable energy projects through scientific study, innovation, and investment. To reduce emissions, corporations in these countries must expand their green technology policies to aid development and focus on fragile economies to increase efficiency in manufacturing and trade in low-carbon emissions products. Various economies should encourage coordination, awareness, and multiple services to embrace a modern living standard by reducing negative environmental consequences and utilizing resources in production more efficiently. This will result in CO2 reductions and long-term economic growth.

6.2 Looking Way Forward.

Industrialists and people in business who are unconcerned about reducing their ecological footprint to achieve high economic growth and environmental economists who do not believe economic expansion can coexist with ecological footprint damage.

Consider the late 1980s, when there was environmental degradation as well as economic growth. Because of the Fog, it was difficult to see the mountain from downtown Los Angeles in 1960, but it is now visible. Similarly, it used to be challenging to ride a bike near the Hudson River in New York City because of the sewage water in the river, but now you can. Today, both states of America are considered large economies as compared to the late 1980s. It is not due to deindustrialization, but rather too strict rules and regulations and advanced pollution control technology.

Pakistan has been the most severely affected by environmental degradation in the last 20 years. Environmental degradation is not a one-nation problem. It is a geographic issue and a challenge for world economies to mitigate its negative impact on the environment and livelihood, which requires international cooperation. This cooperation will help policymakers and environmental protection agencies to understand the importance of these issues and suggest solutions to different environmental degradation scenarios. The coastal areas of Sindh and Baluchistan, particularly Jhimpir and Tatta, are ideal locations for wind turbines in Pakistan. From 2006 to 2015, 250 megawatts of electricity were supplied to the national grade, and 600 megawatts of electricity are expected to be provided to the national grade in October 2021. It is a small step toward clean energy without carbon emissions, and much more should be done. Although its initial investment is high, it is reliable for an extended period of 30 years.

Sindh and Baluchistan's coastal areas, particularly Thar in Sindh, are more suited for wind and solar energy production. The investment in Thar's for renewable energy has both economic and environmental benefits in the long run. According to the Alternative and Renewable Energy Policy (2019), Pakistan and China have realized and encouraged companies to use clean and green energy. In CPEC, the environmental policymaker should design a policy plan for green development regulation and evaluation standards and green financing program. Furthermore, these policies cannot be implemented without the participation of the business sector. This alternative should be exploited by connecting sustainable investment priorities with climate and green financing strategies such as green bonds, debt for nature swaps, social investment bonds, and other financial tools. For Pakistan's long-term future, CPEC would aid in the transition to clean and green energy.

In 2016, Pakistan submitted its first NDC and committed to reducing greenhouse emissions below 20% till 2030 and necessary international support. In other Asian countries, they have reduced the impact of climate change through a green revolution, which uses clean technology to modernize agricultural production and make it self-sufficient. Pakistan should learn from these countries and adopt these green revolution policies to stimulate the ecological footprint and CO_2 emissions.

6.2.1 For Developing Countries.

- Foreign aid should be provided to use the latest technology in all these selected developing countries. Developing and aid recipients' countries should adopt green technology to reduce the pollution level.

- Developed countries should provide fund in term of aid not in the form of loan to the developing countries only for environmental preservation and clean-up purposes because lack of funds for environmental regulations damages the environment.

- The developed nation should impose trade barriers for goods that emit a high level of emission during production.
- The environmental impact of industrial production must be reduced, and production scale must be improved to enhance resource productivity and limit waste generation.

6.3 Future Research.

This study is the initial step in analyzing the Environmental Kuznets Curve and Pollution Heaven Hypothesis utilizing various Spatial Econometric techniques. Future research could look at other pollutants, including CO2 and waste products, as well as the Environmental Kuznets Curve and the Pollution Haven Hypothesis. The current study can be expanded to a worldwide scale. Still, there is a shortage of data on ecological footprints, which can be examined using alternatively weighted matrices such as geography and non-geographic measure of connectivity. This will help to provide a clear picture that non-traditional contiguity provides an accurate representation of spatial relationship among nations compared to the common contiguity criterion.

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