Environment-Growth Nexus: Revisiting Prosperity and Challenges Associated with Foreign Direct Investment

Iqra Arshad* and Muhammad Azhar Khalil**

Received: April 5, 2022 Revised: August 30, 2022 Accepted: September 4, 2022

Abstract

In this study, we develop a model to investigate the interactions between foreign direct investment (FDI), carbon emission (CO_2), fixed capital accumulation (FCA), and economic growth by analyzing the sample from one of the emerging economies in Asia i.e., Pakistan during 1970-2017. In particular, the study examines the impact of FDI on both economic growth and environmental degradation. Using Ordinary Least Square and Johansen Juselius Co-integration approach, we observed that all the explanatory variables (i.e., FDI, CO_2, and FCA) are positively related to the gross domestic product (GDP). Further analysis confirmed the widely accepted belief that FDI positively and significantly contributes to economic growth. However, such economic prosperity is generated at the cost of the environment, as the results show that FDI fosters the current level of CO_2 which in turn poses a substantial challenge to the environmental quality. We offer a set of policies that policymakers should consider in Pakistan's environmental protection policy plan to combat environmental degradation and emissions.

Keywords: Economic Growth, Foreign Direct Investment, Carbon Emission, Environmental Policy

* Graduate School of Public Administration, National Institute of Department Administration
148 Serithai Road, Khlong-Chan, Bangkapi, Bangkok 10240, THAILAND.
E-mail: iqra.arsh@stu.nida.ac.th

** Department of Finance, Martin de Tours School of Management and Economics, Assumption University
Samutprakarn Province 10540, THAILAND.
E-mail: mkhalil@msme.au.edu

จุดเชื่อมสำคัญระหว่างการพัฒนาและสิ่งแวดล้อม : ทบทวนความรุ่งเรืองและความท้าทายการลงทุนโดยตรงจากต่างประเทศ

อิกรา อาชัด และ มูฮำหมัด อัซฮาร คาลิล

รับวันที่ 5 เมษายน 2565 ส่งแก้ไขวันที่ 30 สิงหาคม 2565 ตอบรับตีพิมพ์วันที่ 4 กันยายน 2565

บทคัดย่อ

การวิจัยครั้งนี้พัฒนาโมเดลเพื่อศึกษาความสัมพันธ์ระหว่างการลงทุนโดยตรงจากต่างประเทศ การปล่อยก๊าซคาร์บอนไดออกไซด์ การสะสมทุนถาวรและการเจริญเติบโตทางเศรษฐกิจโดยวิเคราะห์จากกลุ่มตัวอย่างประเทศเศรษฐกิจใหม่ของทวีปเอเชีย ได้แก่ ประเทศปากีสถาน ระหว่างช่วง ค.ศ. 1970-2017 ทั้งนี้การวิจัยมุ่งเน้นศึกษาผลกระทบจากการลงทุนโดยตรงจากต่างประเทศที่มีต่อการเจริญเติบโตทางเศรษฐกิจและความเสื่อมโทรมของสิ่งแวดล้อมผ่านวิธีกำลังสองน้อยที่สุดและกระบวนการวิเคราะห์ความสัมพันธ์ระยะยาวของโจฮานเซนและจูซีเลียส โดยสามารถสังเกตได้ว่าตัวแปลอธิบายทั้งหมด (คือ การลงทุนโดยตรงจากต่างประเทศ การปล่อยก๊าซคาร์บอนไดออกไซด์และการสะสมทุนถาวร) มีความสัมพันธ์เชิงบวกกับผลิตภัณฑ์มวลรวมในประเทศ ประกอบกับผลการวิเคราะห์เพิ่มเติมที่ยืนยันความเชื่อว่าการลงทุนโดยตรงจากต่างประเทศนั้นส่งผลต่อการเจริญเติบโตทางเศรษฐกิจเชิงบวกอย่างมีนัยสำคัญ ทั้งนี้ความเจริญทางเศรษฐกิจดังกล่าวต้องแลกกับผลเสียที่อาจเกิดต่อสิ่งแวดล้อม ดังที่ผลการศึกษาชี้ให้เห็นว่าการลงทุนโดยตรงจากต่างประเทศนั้นคือสาเหตุของระดับก๊าซคาร์บอนไดออกไซด์ในปัจจุบัน ซึ่งส่งผลกระทบต่อคุณภาพของสิ่งแวดล้อมเป็นอย่างมาก การวิจัยจึงขอนำเสนอนโยบายให้ผู้วางนโยบายพิจารณานโยบายการป้องกันด้านสิ่งแวดล้อมของประเทศปากีสถานเพื่อวางแผนรับมือกับการเสื่อมโทรมของสิ่งแวดล้อมและการปล่อยก๊าซ

คำสำคัญ : การเจริญเติบโตทางเศรษฐกิจ การลงทุนโดยตรงจากต่างประเทศ การปล่อยก๊าซคาร์บอนไดออกไซด์ นโยบายด้านสิ่งแวดล้อม

* คณะรัฐประศาสนศาสตร์ สถาบันบัณฑิตพัฒนบริหารศาสตร์
เลขที่ 148 ถนนเสรีไทย แขวงคลองจั่น เขตบางกะปิ กรุงเทพมหานคร 10240
อีเมล : iqra.arsh@stu.nida.ac.th

** แผนกวิชาการเงิน คณะบริหารธุรกิจและเศรษฐศาสตร์ มหาวิทยาลัยอัสสัมชัญ จังหวัดสมุทรปราการ 10540
อีเมล : mkhalil@msme.au.edu

1. Introduction

Whether pollution goes on increasing as an unavoidable byproduct of manufacturing as our economy grows, or will economic growth allow us to achieve better environmental quality? In the current era, environmental deterioration is the key challenge that the globe has been facing for quite a time (Jingkuang Liu et al., 2020; Jinyu Liu et al., 2021). Environmental deterioration exhibits numerous adverse repercussions on sustainable economic development (Murshed et al., 2021; Rehman et al., 2021). While numerous economies around the globe are exerting tremendous efforts to address the urgency of environmental degradation by lowering their CO2 emissions, which are increasing steadily to an unsustainable level. Imagine the level of carbon emissions in 1980 around the globe was 17.79 billion tons, which will be greater than 33 billion tons in the next forty years. Thus, such an alarming situation brings the attention of the globe towards more viable policies to curb the level of emissions. Over the past couple of decades, the relationship between economic development, FDI, and environmental quality has been a contentious topic discussed in the theoretical and scientific literature. Specifically, whether can maintain sustainability by preserving environmental standards has become a global concern.

The level of FDI is kept on increasing globally and multinationals invest largely in developing economies to gain benefit from cheap labor and less stringent environmental regulations. Until 2009, the total volume of FDI globally accounted for $17 trillion, and 27.5% of this is only invested in developing nations. In the late 1990s, Pakistan was successful enough to attract foreign direct investment, which accounts for more than $1 billion. In Despite having a relatively open liberalized market with less stringent environmental policies, Pakistan was unable to maintain the pace of FDI inflows later. The reason behind low FDI inflow is political instability, inefficient financial structure, corruption, terrorism, and weak institutions. In the whole region and amongst neighboring countries, Pakistan is left behind in the race of growth and capturing FDI inflows.

The relationship between FDI and growth is debatable. The impact of FDI is multifaceted, it brings prosperity and growth while posing some severe challenges to sustainability in terms of environmental deterioration. To a larger extent, FDI is regarded as the primary source of economic development due to the inflows of capital technical

upgradation, and knowledge to growing economies (Murshed, Elheddad, et al., 2021).

The FDI inflows make the host nation more prosperous by reaping benefits from advanced technical knowledge and more developed systems with spillover effects resulting in increased efficiency and productivity improvements. On the other hand, FDI has the potential to degrade environmental quality by exaggerating the emissions level within the host nation (Banerjee & Murshed, 2020;Murshed, Rahman, et al., 2021). The two important notions namely; the pollution halo and the pollution haven hypotheses, can help to understand the impact of FDI in terms of growth and challenges simultaneously (Xue et al., 2021). According to the pollution halo idea, FDI is essential for transferring green technology, hence reducing ecological damage (Ahmad et al., 2021; Zeraibi et al., 2021). On the contrary, as Copeland & Taylor, (1994) point out, the pollution haven hypothesis implies that FDI inflows are likely to exacerbate environmental pollution since developed economies choose to locate manufacturing in developing economies due to the availability of cheap labor. Nevertheless, the reason which makes FDI more hazardous is the less stringent environmental regulation by these least developed nations. such least bothered environmental regulations made it so easy for the developed nations to exploit and it they also provides potential to take advantage and invest in pollution-intensive production methods (Murshed, 2020; Nathaniel et al., 2021). However, FDI might assist host countries to grow larger, but due to its pollution-intensive nature, it can deteriorate the environment. Thus, it is imperative to understand the impact of FDI in both directions and regulations in the host nations. By doing so, economies can reap benefits from the FDIs without getting harmed by its pollution-intensive nature.

There is an ongoing debate on the impact of environmental regulations, many argue in the favor and many against. The negative effect of environmental regulation on economic growth and productivity is highlighted by many authors (e.g., Jorgenson & Wilcoxen, 1990; Jorgenson & Wilcoxen, 2018) and (Tahvonen & Kuuluvainen, 1993). They claim that because the elimination of emissions involves resources that might otherwise use for productive activities, tighter environmental regulations would effectively restrict economic growth by raising the cost of output and reducing the overall efficiency of the economy's total inputs. On the contrary, the significance of environmental protection for the stabilization of economic development is stressed by some scholars (e.g., (Maxwell, 1996; Boyd & McClelland, 1999). Many claim that economic practices associated with

producing emissions without imposing environmental regulations lead to economic collapse due to a catastrophic degradation of environmental quality. Investigating the possible conflict between economic development and the atmosphere's quality might have serious ramifications for optimal strategic policies regarding economic growth and pollution control. Currently, developing countries are anxious about the long-term repercussions of environmental pollution and are trying to enact more rigorous environmental policies. However, it is possible that less-developed nations struggling for rapid economic development would permit less restrictive environmental policies. Because deploying pollution control equipment and implementing clean technology could be very expensive. Pakistan's manufacturing sector is amongst the key contributors to economic development and accounts for 20.3% of gross domestic product (GOP,2019). Increased mobilization of foreign resources is needed to boost industrial production and be considered an important success factor (Khan & Kim, 1999). With prudent macroeconomic policies and many structural reforms, it is imperative for Pakistan to welcomes international investors and local producers (Husain, 2009; Desbordes, 2010).

The association between carbon emissions and FDI has already been explored; however, there is a larger need to understand the impact of FDI in both directions (prosperity and challenges). FDI could bring growth as well as poses challenges to the environment that raises the need towards stringent environmental regulations for the sustainable future in developing economies. Moreover, the given study also examined the Environmental Protection Ordinance of Pakistan to understand the bottlenecks and provide a policy plan that need to be implemented for sustainable future.

1.1 Pakistan's Environmental Protection Ordinance-1983 and Policy Process

The Government of Pakistan created the Pakistan Environmental Protection Ordinance (PEPO) in 1983. Although the Pakistan Environmental Protection Ordinance-1983 is similar to the US National Environmental Policy Act-1969, the reflective practices are different in both countries. However, after 30 years of its enactment by the Government, it did not yield the desired results compared to the USA. PEPO was not a significant success in terms of enforcement, and various factors can be linked to its failure. The main reason behind its failure is the policy mechanism in Pakistan, which is shaped and controlled by leaders of political parties, bureaucracy, and local elites' agendas. In Pakistan's policy

mechanism, the general public's involvement and group influences have secondary importance. Despite significant control over policy initiation, political and bureaucratic considerations are important predictors of the environmental policy system. The execution of the policy is likely to be affected largely by different stakeholders at the community level. Rigidity and elitism are the byproduct of the Bureaucracy in Pakistan, which prohibits the acceptance of reforms. This research aims to provide reliable, authentic, and practical information on PEPO and establish a new Environmental Policy Plan for Pakistan for better implementation.

Even after 1983, Environmental Protection Ordinance was implemented, the term "environment" was obscure to Pakistan's citizens. Awareness of environmental issues was devoid, and due to the low literacy rate, whatever efforts practiced made a slight improvement. This indicates that the evidence related to environmental legislation development was inadequate, especially in the longer term. The challenge faced by the environment must be taken up vigorously by the Central Government and other levels of government and target groups to give the policies a strong start (Malik, 1993). However, Ahmed (2002) argued that the laws are already in place, the implementation of laws and policies is a major issue, and it depends on the country's political will.

1.2 Country Profile

The Islamic Republic of Pakistan, on 14 August 1947, appeared on the World Map. It occupies 796,096 square kilometers and shares borders with India, China, Afghanistan, and Iran. Pakistan's location is of particular importance in South Asia as it shares the Eastern region with the West. Pakistan is the world's 6th largest country and comprises over 220 million individuals. In a middle-income country with a per capita GDP (a current US Dollar) of 1547,853, roughly 24.3 percent people live below the national poverty line.

The volume of Carbon emissions production in Pakistan in 2016 was 0.20 million kilotons, and the level of Foreign Direct Investment in Pakistan was 2.218 billion US dollars. On the contrary, in Thailand, the carbon emission production was 0.283 million kilotons, and its foreign direct investment was 6.316 billion US dollars in Thailand. These figures indicate that foreign direct investment does not fully explain the extent of Co2 emissions in Pakistan, and FDI is not solely responsible for Pakistan being among the most polluted countries. As a practical guide to lawmakers, environmental managers, and political

leaders, this study's findings can help to be informed regarding optimal environmental policy to improve the quality of the environment in Pakistan. It is worth mentioning that the analysis undertaken in the current study is imperative because it serves three purposes concurrently by using secondary time series data from 1970-2017 that had not been used in a single study in the past. Secondly, it investigates the effect of FDI in both directions; prosperity and challenges. The study has explored the impact of FDI on economic growth (prosperity) and challenges poses to environment. Lastly, the analysis shed light on Pakistan's environmental protection laws and provided a potential environment strategy plan.

The rest of our study is organized in the following way: the Review of literature section explains the pertinent literature regarding Energy Usage, Growth, Environmental Deterioration, and Foreign Direct Investment. Moreover, it also includes the hypotheses development section. The third section of the paper include the methodology part, explains model specification, and discusses the econometric estimations for models. The fourth and fifth section of the study discusses the findings, made conclusion, and summarizes the study's policy implications. Lastly, the limitations of the study have also been discussed.

2. Literature Review

In recent times, we have seen scholars pay much more attention towards sustainability and sustainable economic growth. The focus of these studies is on the effective management of hazardous waste, green consumption and production, alternative sources of energy instead of traditional ones, and their impact on the sustainable growth (Musatti et al., 2017; Ahmed et al., 2020; Jingkuang Liu et al., 2020; Zhao et al., 2020; Wu et al., 2021; Li et al., 2021; Yu, 2021; Peng et al., 2021).The studied variable in the given research can be divided into two categories. The first group delves into the intricacies of the relationship between energy consumption, growth, and environmental damage. The second group look at the link between environmental degradation, growth, and foreign direct investment.

2.1 Energy Usage, Growth, and Environmental Deterioration

Grossman & Krueger (1991) make initial attempts to ascertain the veracity of Environmental Kuznets Curve (EKC) and investigate the dynamical impacts of growth on

the quality of environment. The EKC hypothesis presume that initially growth comes on the cost of environmental deterioration but later, the negative effects are offset by the specified level of growth (Ahmad et al., 2021; Murshed, Haseeb, et al., 2021). Many scholars made attempts to investigate the EKC notion in different countries. Mikayilov et al. (2018) and Zambrano-Monserrate et al. (2018) investigated the association between growth and the quality of environment however, they could not find the evidence for EKC hypothesis. Similarly, Richmond & Kaufmann (2006) and Omisakin & Olusegun (2009) explore the growth-environment nexus in 36 countries of South Africa, and findings reveal that there is no relationship between the variables. Many researchers provide the reasons regarding why EKC hypothesis not holding true because it rightly made assumption that growth hinder the sustainability however, a specified level of growth is not enough to offset the adverse impacts of emissions on environment (Bandyopadhyay & Rej, 2021).

On the contrary many researches such as (Alam et al., 2012; Govindaraju & Tang 2013; Katrakilidis et al., 2016) found that the EKC hypothesis holds true, with a rapid economic growth the environmental quality is getting better in Greece, India, Bangladesh, and China. K. Ahmed & Long (2012) and M. U. Rehman & Rashid (2017) pointed out that GDP growth brings betterment in term of environmental quality. The economic growth leads towards lower level of carbon emissions in China (Jalil & Mahmud 2009; He & Lin 2019; Zhu et al. 2019). Adu & Denkyirah (2017) investigate the relationship in West Africa and find that in short-run the economic growth harm the environment but in the long-run the relationship does not exist. The economic growth deteriorates the environment through the creation of carbon emissions in Qatar (Mrabet & Alsamara, 2017).

2.2 Environmental Deterioration, Growth, and Foreign Direct Investment

While various researchers have examined the complex relationship between environmental degradation, FDI, and Growth their outcomes remain uncertain. Additionally, some studies argue for the legitimacy of the pollution haven concept, while others assert the pollution halo idea's validity. This variation in outcomes could be explained by the selection of economies for research, the variables utilized for quality of environment and FDI, the data sources, and the sophistication of econometric techniques (Letchumanan & Kodama, 2000).

Numerous experts believe that, in addition to economic expansion, FDI inflows exhibit negative effects on environment. Panayotou (2016) investigated the association between carbon emissions and GDP; results suggested a direct correlation between GDP growth and environmental degradation. Arcelus & Arocena (2005) examined the relationship between GDP, economic consumption, and carbon emissions using the time series data from 1973 to 2008. The findings show a unidirectional causality flowing from GDP and Carbon emission to growth in the longer term. Nasir et al. (2019) explore the relationship between carbon emissions, growth and FDI in 5 ASEAN countries, the findings suggests that both growth and FDI deteriorating the quality of environment. Consequently, the position of FDI has become contentious and controversial. It is argued that economic growth is stimulated by FDI but not free from negative externalities of the environment (Shahbaz et al., 2015). Through less strict environmental control, weakened environmental apprehensions by developing nations created situations that motivated multinationals to invest in developing countries to increase their production by relaxed environmental policies (Cole & Elliott, 2003). This situation allows multinationals to benefit immensely from decreased production costs; nevertheless, weaker environmental laws and cheaper production costs may result in environmental destruction in the host nation.

FDI contributes to the host economy by enhancing economic growth (Alfaro et al., 2010). FDI fills the gap between domestic savings and targeted investment (Ndikumana & Verick, 2008). FDI also increases economic growth by providing direct access to capital, creating positive externalities, shifting innovative technology, and increasing efficiency benefits (Lee et al. 2013; Shahbaz et al., 2015). FDI delivers innovative and energy-efficient technology and operates under best management practices that improve the host country's environmental quality. International investors who employ technologically advanced equipment can minimize energy consumption and sustain the environment. Conversely, due to energy-intensive equipment and larger emission production, FDI degrades environmental quality. This mismatch in empirical evidence on the FDI-emissions linkage provides a foundation for re-examining the FDI, carbon emissions relationship with growth.

2.3 Hypotheses Development

H1: There is a positive and significant relationship between FDI and Gross Domestic Product in Pakistan

H2: Foreign Direct Investment (FDI) sustains a significantly positive relationship with Carbon Emissions in Pakistan

H3: Fixed Capital Accumulation (FCA) sustains a significantly positive relationship with Gross Domestic Product and with Carbon Emissions

3. Methodology

3.1 Data

Annual time series data **from 1970 to 2020** were used in the given research. The link between Pakistan's Gross Domestic Product, Foreign Direct Investment, Carbon Emissions, and Gross Fixed Capital Formation was investigated in this study. The data was gathered from World Bank indicators. The data on gross domestic product is in real form by using constant prices (2015) to account for the inflationary impact. Similar to GDP, the fixed capital accumulation is also in real form; Carbon emissions are measured in million kilotons. Furthermore, All the data are converted into logarithm forms in order to avoid the problem of skewness and reduce the magnitude of variation since there is usually a problem of large variation when dealing with GDP data.

Table 1: Model Description and Specification

Variables	Abbreviated By	Unit of Variable	Sources
Dependent Variable Gross Domestic Product	GDP	Constant (2015) US Dollars	World Bank
Independent Variables Carbon Emissions	CO_2	Million kilotons	World Bank
Foreign Direct Investment	FDI	Current US Dollars	World Bank
Fixed Capital Accumulation	FCA	Constant (2015) US Dollars	World Bank

Table 2: Descriptive Statistics

Variable	Mean	Std. Dev	Standard Error	Min	Max
CO_2	11.65	0.35	0.06	10.99	26.51
FDI	19.40	2.02	0.29	13.82	22.44
FCA	23.73	0.54	0.08	22.75	24.61
GDP	25.43	0.69	0.10	24.26	26.51
N	50				

The current study examines the link between explanatory and exploratory variables using time series data from 1970 to 2020. The Augmented-Dickey Fuller (ADF) test is used to examine the data's stationary. The concept was endorsed by (Dickey & Fuller, 1979) for working on a non-stationarity test. The co-integration equation would then be approximated using a test created by (Johansen & Juselius, 1990), known as the Johansen Juselius co-integration test.

The following equations is measured to estimate the relationship between variables:

$LGDP_t = \beta_0 + \beta 1LCO2t + \beta 2LFDIt + \beta 3LFCAt + \varepsilon_t$ .....**Model 1**

$CO_{2t} = \beta_0 + \beta 1LFDIt + \beta 2LFCAt + \varepsilon_t$ .....**Model 2**

3.2 Results and Discussion

3.2.1 Model 1

The statistical findings of the analysis are further divided into tests of stationarity of variables and coefficient estimations of short as well as long run.

3.2.2 Unit Root Test

The first step is to employ the ADF test to check whether the variables have unit root or not. The test result is given in table 3 which indicates that at level *I*(0), time series data is non-stationary. The rejection of null hypothesis in order to make variables stationary at 1% level of significance; GDP, CO_2, FDI & FCA become stationary at level *I*(1) which specifies the deterministic trend.

Table 3: Results of Augmented Dickey-Fuller Test (ADF)

Variables	t-Statistics	Probability	Conclusion
LGDP	-4.852646**	0.0000	I (1)
LCO_2	-5.523411**	0.0100	I (1)
LFDI	-6.372233**	0.000	I (1)
LFCA	-5.228289**	0.0000	I (1)

Source: Estimated by author using EViews

Since all the variables are integrated at same order, this implies that the long-run equilibrium relationship exist between these variables. Thus, the co-integration equation measured in the following table.

3.2.3 Unrestricted Co-Integration Rank Test & Lag Selection

Johansen & Juselius (1990) devised one of the most important tests for examining co-integration, which used not only to determine the size and symbols of long-run relationships among variables, but also measures the marginal values for the given equation. The Johansen Juselius co-integration test starts with unrestricted VAR to choose the optimal lag. The selection of lag is based on the Akaike Information Criterion, after determining the appropriate lag, the Johansen cointegration test with (1-p) lag was applied.

Table 4: Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.512234	34.91243	32.82345	0.0497
At most 1	0.434678	27.78653	28.59664	0.0771
At most 2	0.283031	15.65324	22.12462	0.4579
At most 3	0.287453	12.75453	13.27890	0.1513
At most 4 *	0.085678	5.564234	4.905623	0.0388

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

* denotes rejection of the hypothesis at the 0.05 level

Source: Estimated by author using EViews

By integrating the Trace Test and Max Eigen Statistics, the Johansen Juselius co-integration test provide evidence for the existence of a long-run relationship between (GDP, FDI, CO2 & FCA). The max-eigen statistics shows there exist one cointegration equation at 5% level of significance.

Table 5: Normalized Co-integrating Coefficients: 1 Co-integrating Equation(s)

LGDP	**1.00**		
	Coefficients	Standard error	t-statistics
LCO_2	0.136082	0.03674	3.703919
LFDI	1.256742	0.22456	5.596464
LFCA	1.467890	0.21803	6.732513

The findings reveal that all independent variables are positively related to gross domestic product. According to the findings, a 1% rise in carbon emissions results in a 0.13 percent increase in gross domestic product. Besides carbon emissions, the one percent increase in foreign direct investment brought roughly 1.2% percent rise in gross domestic product. The fixed capital accumulation brings 1.4% increase in gross domestic product. The fixed capital accumulation is the major contributor to gross domestic product. Additionally, residual diagnostic tests were used to determine the existence of autocorrelation and heteroskedasticity problems. Serial Correlation LM Test and VEC residual heteroskedasticity tests demonstrate that the autocorrelation and heteroskedasticity problems in the series were non-existent.

Table 6: Serial Correlation LM Tests

Sample: 1970 2020 **Included observations: 48**	
Null Hypothesis: no serial correlation at lag order h	
Lag	Prob.
1	0.3385
2	0.3439

Table 7: Heteroskedasticity Tests

No Cross Terms (only levels and squares) **Sample: 1970 2020** **Included observations: 48**	
Joint Test	
Chi Square	**Prob**
304.2536	0.7824

3.2.4 Granger Causality Test

Lastly, the granger-causality test is employed to look at the direction of causality among variables. The notion of causality was elaborated by (Granger, 1969) and it became most popular in economics and econometrics literature. Granger explained the variable Yt to be caused by other variable Xt if the previous variable can be predicted by past values of Xt. The decision criteria regarding acceptance of the null hypothesis (accept Ho if the p-value is greater than the level of significance) if not then reject the null hypothesis which means there is a causal relationship between variables (since the p-value is less than the level of significance).

Table 8: Granger-Causality Test

Variables	F-Test	P-value
$L(CO_2) \rightarrow L(GDP)$	5.89	0.02*
$L(GDP) \rightarrow L(CO_2)$	1.85	0.16
$L(FDI) \rightarrow L(GDP)$	1.92	0.19
$L(GDP) \rightarrow L(FDI)$	5.90	0.01*
$L(FCA) \rightarrow L(GDP)$	2.68	0.22
$L(GDP) \rightarrow L(FCA)$	3.67	0.01*
$L(FDI) \rightarrow L(CO_2)$	4.78	0.04*
$L(CO_2) \rightarrow L(FDI)$	2.15	0.23

Note: Causality between L(GDP), L(CO2), L(FDI) & L(FCA) of Pakistan from 1970 to 2020

* indicates the rejection of null hypothesis at 5% significance level

The result indicates that FDI and FCA do not granger GDP in the case of Pakistan and the result is consistent with (Attari et al., 2011), in the case of GDP, it does granger FDI and FCA which shows that there is a uni-directional relationship between GDP and FDI; GDP and CO2; consistent with (Faruku et al., 2011; Attari et al., 2011). Wang (2018) explained that in developing nation the carbon emission granger the GDP and there is a one-way causal link between GDP and CO2. Moreover, there is a uni-direction causality between GDP and FCA in Pakistan consistent with (Zahir et al., 2020).

Model 2: Ordinary Least Square

Dependent Variable: LCO_2 **Method: Least Squares**				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.322713	3.428511	0.385798	0.7042
LFDI	0.402027	0.094673	4.246471	0.0934
LFCA	0.542202	0.067431	8.040795	0.0000
R-squared	0.988284	Mean dependent var		13.54385
Adjusted R-squared	0.984379	S.D. dependent var		0.443995
S.E. of regression	0.055492	Akaike info criterion		-2.713646
Sum squared resid	0.055429	Schwarz criterion		-2.372361
Log likelihood	40.92058	Hannan-Quinn criter		-2.618988
F-statistic	253.0646	Durbin-Watson stat		1.889079
Prob (F-statistic)	0.000000			

3.2.5 Model 2

The second model was estimated using a different method—ordinary least squares estimation—to compare it to other studies that used OLS estimates, allowing our study to give a comparison and propose policy recommendations. The findings suggested that fixed capital accumulation positively and significantly correlated with carbon emissions. On the contrary, foreign direct investment is also positively correlated with carbon emissions but was statistically significant at the 10% significance level. Pakistan has long been known as the most afflicted and polluted country due to its high air pollution level (Kalim, 2001). According to the Climate Risk Index Study (Eckstein et al., 2017) Pakistan is probably the most harmed nation by climate change in recent years. There could be some other factors behind this the FDI alone is not responsible for the whole carbon emission in Pakistan since the significance of relationship is at 10%.

4. Conclusion

Findings suggested that Carbon emissions, foreign direct investmen kistan's gross domestic product. This imply that emission and foreign direct investment brings

prosperity in term of economic growth. Foreign direct investment sustained a positive significant relationship with carbon emissions at 10%, which indicates that along with prosperity FDI poses some serious challenges to the environment in term of emission and degradation of environmental quality. It is noteworthy that FDI does not granger cause the GDP because of many reasons. Firstly, the impact depends upon the absorptive capacity of human capital and by the extent of spillover effect. Secondly, the level of foreign direct investment (FDI) in Pakistan is low relative to the neighboring countries and even in the South Asian region which results in lower impact on GDP. However, the FDI do contribute in the creation of employment, bringing new technologies and knowledge. Thus, the government should induce lucrative policies to attract the FDI. On the other hand, foreign direct investment is also one of the contributors in the carbon emission in Pakistani economy, henceforth, government need to impose environmental laws and restrictions for foreign investors to safeguard the host economy.

Furthermore, the positive association between fixed capital accumulation and carbon emission indicated that the fixed capital within the country produces a lot of emissions. There is a huge need at the policy level to use better-modified technology and pollution abatement equipment instead of only increasing the low-level fixed capital accumulation. The study's major finding indicated that there is an arising need to alter the energy resources to combat environmental degradation.

5. Policy Recommendations

Being among the most polluted economies, Pakistan needs to review the progress of the environmental policy over the past decades and the measures applied for its implementation. It needs to preview plans and programs for environmental policy to do so. Its re-evaluation is of great importance and needs to be improved and expanded. This research proposes a comprehensive and inclusive policy recommendation for reducing CO2 emissions, which results in improved human capital accumulation and productivity. The government must impose environmentally sound restriction to safeguard the host economy. FDI brings newer and eco-efficient technologies to the host country however, due to less stringent environmental policies, the developing nations did not reap the true essence from FDI. Thus, Pakistan needs to impose strict rules for the foreign investors. FDI should not be considered as an end per se rather it should be considered as a way

to support other initiatives of development so the nation can get benefit from the spillover effect

Limitations of the Study

Data accessibility is a public good (Varian, 1992), and like other public goods, it is immensely intricate. If data availability were a straightforward issue, it would have been addressed long ago. The current study uses time-series data from 1970 to 2020 and encountered many challenges regarding data availability. The present study intended to investigate the impact of foreign direct investment (FDI) on economic growth and carbon emissions. It hypothesized that FDI works in both directions brings prosperity (growth) and poses severe challenges to the environment. Thus, FDI had a positive and significant association with carbon emissions in the Pakistani context at 10% level of significance.

According to the literature, the pollution halo theory asserts that FDI incorporating innovative and energy-efficient technology and operating under best management practices improves the host country's environmental quality. So, it became crucial to examine the fact that if FDI comes with better technology and pollution abatement equipment, does it contribute to reducing the level of emission in Pakistan or not. However, the author was unable to obtain data for these factors (Fixed capital accumulation based on technology) for such a long span; moreover, the data collection is not yet started on such sophisticated variables in Pakistan.

Another vital variable that could be helpful to understand the overall situation of Pakistan might be the province wise data on carbon emission. It would be beneficial to get the data regarding problematic locations with a higher emission volume; however, the sincere efforts to obtain the data went into the vein. To summarize, the issues listed above are the study's shortcomings, which can address in the future with the availability of larger data sets on fixed capital accumulation based on technology and province-level statistics on carbon emissions.

References

Adu, D. T., & Denkyirah, E. K. (2017). *Economic growth and environmental pollution in West Africa: Testing the Environmental Kuznets Curve hypothesis*.

Ahmad, M., Jiang, P., Murshed, M., Shehzad, K., Akram, R., Cui, L., & Khan, Z. (2021). Modelling the dynamic linkages between eco-innovation, urbanization, economic growth and ecological footprints for G7 countries: does financial globalization matter? *Sustainable Cities and Society*, *70*, 102881.

Ahmed, K., & Long, W. (2012). Environmental Kuznets curve and Pakistan: an empirical analysis. *Procedia Economics and Finance*, *1*, 4-13.

Ahmed, Z., Zafar, M. W., & Mansoor, S. (2020). Analyzing the linkage between military spending, economic growth, and ecological footprint in Pakistan: evidence from cointegration and bootstrap causality. *Environmental Science and Pollution Research*, *27*(33), 41551-41567.

Alam, M. J., Begum, I. A., Buysse, J., & Van Huylenbroeck, G. (2012). Energy consumption, carbon emissions and economic growth nexus in Bangladesh: Cointegration and dynamic causality analysis. *Energy Policy*, *45*, 217-225.

Alfaro, L., Chanda, A., Kalemli-Ozcan, S., & Sayek, S. (2010). Does foreign direct investment promote growth? Exploring the role of financial markets on linkages. *Journal of Development Economics*, *91*(2), 242-256.

Arcelus, F. J., & Arocena, P. (2005). Productivity differences across OECD countries in the presence of environmental constraints. *Journal of the Operational Research Society*, *56*(12), 1352-1362.

Attari, M. I. J., Kamal, Y., & Attaria, S. N. (2011). The causal link between foreign direct investment (FDI) and economic growth in Pakistan economy. *The Journal of Commerce*, *3*(4), 61.

Bandyopadhyay, A., & Rej, S. (2021). Can nuclear energy fuel an environmentally sustainable economic growth? Revisiting the EKC hypothesis for India. *Environmental Science and Pollution Research*, *28*(44), 63065-63086.

Banerjee, S., & Murshed, M. (2020). Do emissions implied in net export validate the pollution haven conjecture? Analysis of G7 and BRICS countries. *International Journal of Sustainable Economy*, *12*(3), 297-319.

Boyd, G. A., & McClelland, J. D. (1999). The impact of environmental constraints on productivity improvement in integrated paper plants. *Journal of Environmental Economics and Management*, *38*(2), 121-142.

Cole, M. A., & Elliott, R. J. R. (2003). Determining the trade–environment composition effect: the role of capital, labor and environmental regulations. *Journal of Environmental Economics and Management*, *46*(3), 363-383.

Copeland, B. R., & Taylor, M. S. (1994). North-South trade and the environment. *The Quarterly Journal of Economics*, *109*(3), 755-787.

Desbordes, R. (2010). Global and diplomatic political risks and foreign direct investment. *Economics & Politics*, *22*(1), 92-125.

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, *74*(366a), 427-431.

Eckstein, D., Künzel, V., & Schäfer, L. (2017). Global climate risk index 2018. *Germanwatch, Bonn*.

Faruku, A. Z., Asare, B. K., Yakubu, M., & Shehu, L. (2011). Causality analysis of the impact of foreign direct investment on GDP in Nigeria. *Nigerian Journal of Basic and Applied Sciences*, *19*(1).

Govindaraju, V. G. R. C., & Tang, C. F. (2013). The dynamic links between CO2 emissions, economic growth and coal consumption in China and India. *Applied Energy*, *104*, 310-318.

Granger, C. W. J. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica: Journal of the Econometric Society*, 424-438.

Grossman, G. M., & Krueger, A. B. (1991). *Environmental impacts of a North American free trade agreement*. National Bureau of economic research Cambridge, Mass., USA.

He, Y., & Lin, B. (2019). Investigating environmental Kuznets curve from an energy intensity perspective: empirical evidence from China. *Journal of Cleaner Production*, *234*, 1013-1022.

Husain, I. (2009). The role of politics in Pakistan's Economy. *Journal of International Affairs*, *63*(1), 1-18.

Jalil, A., & Mahmud, S. F. (2009). Environment Kuznets curve for CO2 emissions: a cointegration analysis for China. *Energy Policy*, *37*(12), 5167-5172.

Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration—with appucations to the demand for money. *Oxford Bulletin of Economics and Statistics*, *52*(2), 169-210.

Jorgenson, D. W., & Wilcoxen, P. J. (1990). Environmental regulation and US economic growth. *The Rand Journal of Economics*, 314-340.

Jorgenson, D. W., & Wilcoxen, P. J. (2018). Environmental regulation and US economic growth. In *Economic Costs and Consequences of Environmental Regulation* (pp. 225-252). Taylor and Francis.

Kalim, R. (2001). Capital intensity in the large-scale manufacturing of Pakistan. *Pakistan Economic and Social Review*, 135-151.

Katrakilidis, C., Kyritsis, I., & Patsika, V. (2016). The dynamic linkages between economic growth, environmental quality and health in Greece. *Applied Economics Letters*, *23*(3), 217-221.

Khan, A., & Kim, Y.-H. (1999). *Foreign direct investment in Pakistan: policy issues and operational implications*.

Lee, J., Lapira, E., Bagheri, B., & Kao, H. (2013). Recent advances and trends in predictive manufacturing systems in big data environment. *Manufacturing Letters*, *1*(1), 38-41.

Letchumanan, R., & Kodama, F. (2000). Reconciling the conflict between thepollution-haven'hypothesis and an emerging trajectory of international technology transfer. *Research Policy*, *29*(1), 59-79.

Li, J., Hu, Z., Shi, V., & Wang, Q. (2021). Manufacturer's encroachment strategy with substitutable green products. *International Journal of Production Economics*, *235*, 108102.

Liu, Jingkuang, Yi, Y., & Wang, X. (2020). Exploring factors influencing construction waste reduction: a structural equation modeling approach. *Journal of Cleaner Production*, *276*, 123185.

Liu, Jinyu, Murshed, M., Chen, F., Shahbaz, M., Kirikkaleli, D., & Khan, Z. (2021). An empirical analysis of the household consumption-induced carbon emissions in China. *Sustainable Production and Consumption*, *26*, 943-957.

Maxwell, J. W. (1996). What to do when win-win won't work: Environmental strategies for costly regulation. *Business Horizons*, *39*(5), 60-64.

Mikayilov, J. I., Galeotti, M., & Hasanov, F. J. (2018). The impact of economic growth on CO2 emissions in Azerbaijan. *Journal of Cleaner Production*, *197*, 1558-1572.

Mrabet, Z., & Alsamara, M. (2017). Testing the Kuznets Curve hypothesis for Qatar: A comparison between carbon dioxide and ecological footprint. *Renewable and Sustainable Energy Reviews*, *70*, 1366-1375.

Murshed, M. (2020). An empirical analysis of the non-linear impacts of ICT-trade openness on renewable energy transition, energy efficiency, clean cooking fuel access and environmental sustainability in South Asia. *Environmental Science and Pollution Research*, *27*(29), 36254-36281.

Murshed, M., Ali, S. R., & Banerjee, S. (2021). Consumption of liquefied petroleum gas and the EKC hypothesis in South Asia: evidence from cross-sectionally dependent heterogeneous panel data with structural breaks. *Energy, Ecology and Environment*, *6*(4), 353-377.

Murshed, M., Elheddad, M., Ahmed, R., Bassim, M., & Than, E. T. (2021). Foreign direct investments, renewable electricity output, and ecological footprints: do financial globalization facilitate renewable energy transition and environmental welfare in Bangladesh? *Asia-Pacific Financial Markets*, 1-46.

Murshed, M., Haseeb, M., & Alam, M. (2021). The Environmental Kuznets Curve hypothesis for carbon and ecological footprints in South Asia: the role of renewable energy. *GeoJournal*, 1-28.

Murshed, M., Rahman, M., Alam, M. S., Ahmad, P., & Dagar, V. (2021). The nexus between environmental regulations, economic growth, and environmental sustainability: linking environmental patents to ecological footprint reduction in South Asia. *Environmental Science and Pollution Research*, *28*(36), 49967-49988.

Musatti, A., Ficara, E., Mapelli, C., Sambusiti, C., & Rollini, M. (2017). Use of solid digestate for lignocellulolytic enzymes production through submerged fungal fermentation. *Journal of Environmental Management*, *199*, 1-6.

Nasir, M. A., Huynh, T. L. D., & Tram, H. T. X. (2019). Role of financial development, economic growth & foreign direct investment in driving climate change: A case of emerging ASEAN. *Journal of Environmental Management*, *242*, 131-141.

Nathaniel, S. P., Murshed, M., & Bassim, M. (2021). The nexus between economic growth, energy use, international trade and ecological footprints: the role of environmental regulations in N11 countries. *Energy, Ecology and Environment*, *6*(6), 496-512.

Ndikumana, L., & Verick, S. (2008). The linkages between FDI and domestic investment: Unravelling the developmental impact of foreign investment in Sub-Saharan Africa. *Development Policy Review*, *26*(6), 713-726.

Omisakin, D., & Olusegun, A. (2009). Economic growth and environmental quality in Nigeria: does environmental Kuznets curve hypothesis hold? *Environmental Research Journal*, *3*(1), 14-18.

Panayotou, T. (2016). Economic growth and the environment. *The Environment in Anthropology*, *24*, 140-148.

Peng, X., Liu, Z., & Jiang, D. (2021). A review of multiphase energy conversion in wind power generation. *Renewable and Sustainable Energy Reviews*, *147*, 111172.

Rehman, A., Ulucak, R., Murshed, M., Ma, H., & Isik, C. (2021). An asymmetric analysis of the impacts of forests, livestock and economic progress on CO2 emissions in China. *J Environ Manag*, *294*, 113059.

Rehman, M. U., & Rashid, M. (2017). Energy consumption to environmental degradation, the growth appetite in SAARC nations. *Renewable Energy*, *111*, 284-294.

Richmond, A. K., & Kaufmann, R. K. (2006). Is there a turning point in the relationship between income and energy use and/or carbon emissions? *Ecological Economics*, *56*(2), 176-189.

Shahbaz, M., Nasreen, S., Abbas, F., & Anis, O. (2015). Does foreign direct investment impede environmental quality in high-, middle-, and low-income countries? *Energy Economics*, *51*, 275-287.

Tahvonen, O., & Kuuluvainen, J. (1993). Economic growth, pollution, and renewable resources. *Journal of Environmental Economics and Management*, *24*(2), 101-118.

Varian, H. R. (1992). *Microeconomic analysis* (Issue 338.5 V299m 1992). WW Norton.

Wang, M. (2018). A Granger causality analysis between the GDP and CO2 emissions of major emitters and implications for international climate governance. *Chinese Journal of Urban and Environmental Studies*, *6*(01), 1850004.

Wu, B., Jin, C., Monfort, A., & Hua, D. (2021). Generous charity to preserve green image? Exploring linkage between strategic donations and environmental misconduct. *Journal of Business Research*, *131*, 839-850.

Xue, L., Haseeb, M., Mahmood, H., Alkhateeb, T. T. Y., & Murshed, M. (2021). Renewable energy use and ecological footprints mitigation: evidence from selected South Asian economies. *Sustainability*, *13*(4), 1613.

Yu, B. (2021). Urban spatial structure and total-factor energy efficiency in Chinese provinces. *Ecological Indicators*, *126*, 107662.

Zahir, S., Hayat, K., & Haider, A. (2020). The Causality between Gross Fixed Capital Formation, Trade Deficit, Exchange Rate, and the Economic Growth of Pakistan. *International Review of Management and Business Research*, *09*(04), 138-147. https://irmbrjournal.com/papers/1607856111.pdf

Zambrano-Monserrate, M. A., Silva-Zambrano, C. A., Davalos-Penafiel, J. L., Zambrano-Monserrate, A., & Ruano, M. A. (2018). Testing environmental Kuznets curve hypothesis in Peru: The role of renewable electricity, petroleum and dry natural gas. *Renewable and Sustainable Energy Reviews*, *82*, 4170-4178.

Zeraibi, A., Balsalobre-Lorente, D., & Murshed, M. (2021). The influences of renewable electricity generation, technological innovation, financial development, and economic growth on ecological footprints in ASEAN-5 countries. *Environmental Science and Pollution Research*, *28*(37), 51003-51021.

Zhao, X., Gu, B., Gao, F., & Chen, S. (2020). Matching model of energy supply and demand of the integrated energy system in coastal areas. *Journal of Coastal Research*, *103*(SI), 983-989.

Zhu, L., Hao, Y., Lu, Z.-N., Wu, H., & Ran, Q. (2019). Do economic activities cause air pollution? Evidence from China's major cities. *Sustainable Cities and Society*, *49*, 101593.

Zahir, S., Hayat, K., & Haider, A. (2020). The Causality between Gross Fixed Capital Formation, Trade Deficit, Exchange Rate, and the Economic Growth of Pakistan. *International Review of Management and Business Research*, *09*(04), 138-147. https://irmbrjournal.com/papers/1607856111.pdf