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Causal Nexus Among the Economic Growth, Energy Consumption and Environmental Degradation in Pakistan

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Abstract:
The study objective is to assess the reciprocal relationship between energy consumption and economic growth in Pakistan, analyzing how each factor influences the other. Additionally, it seeks to investigate the combined impact of energy consumption and economic growth on environmental degradation within the country. The study modifies the Stern, Solow growth models, and Kuznets curve to incorporate new variables and examine their interrelationship with economic growth, energy consumption, and environmental degradation in Pakistan. Time series secondary data covering the period from 1975 to 2016 will be collected for analysis. The model explains the influence of energy consumption, foreign direct investment, gross fixed capital formation, and public debt on GDP. The empirical findings indicate a positive relationship between energy consumption and economic growth in Pakistan, with evidence of bidirectional causality in both short and long terms, supporting the feedback hypothesis. This underscores the intricate dynamics among economic growth, energy consumption, and industrial production, emphasizing the necessity of sustainable energy strategies to reconcile economic advancement with environmental concerns. Achieving this balance necessitates tailored policies and practices by governments and industries, crucial for ensuring effective and sustainable development outcomes in terms of renewable energy, environmentally friendly transportation, population and urban development strategies.

Keywords: Gross Domestic Product, Energy Consumption, Environmental Degradation, Energy Price, Industrialization.

Introduction:

The issue of energy consumption, economic growth, and environmental degradation in Pakistan is a complex and intricate dilemma. The country faces significant environmental challenges such as air and water pollution, deforestation, soil erosion, and a decrease in biodiversity. The extensive reliance on fossil fuels such as coal, oil, and natural gas by the energy sector is a major contributing

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factor to this environmental deterioration. This reliance leads to the release of greenhouse gases, air pollutants, and the depletion of natural resources. Pakistan relies heavily on fossil fuels, specifically natural gas and oil, which make up a significant portion of its energy consumption. The use of these fossil fuels in power generation and transportation not only contributes to air pollution but also worsens climate change by emitting greenhouse gases like carbon dioxide (CO2) and methane (CH4). On the other hand, energy consumption is crucial to driving economic advancement, with industries, businesses, and households depending on it for various production and consumption activities. In Pakistan, the demand for energy has continuously increased due to population growth, urban expansion, and industrial progress. As the economy expands, the need for energy rises to fuel sectors like manufacturing, agriculture, transportation, and services.

Achieving a balance between economic progress and environmental conservation is a major challenge for policymakers in Pakistan.To address the complex relationship between energy consumption, economic development, and environmental degradation, a comprehensive approach. Pakistan has significant renewable energy potential, including solar, wind, hydro, and biomass resources. Investing in renewable energy infrastructure not only reduces dependence on fossil fuels but also stimulates economic growth, creates job opportunities, and fosters technological advancement. Energy consumption is a fundamental component and a driving force behind economic growth. An uninterrupted energy supply is a necessary condition to carry out economic activities that accelerate economic growth and development. The use of energy is required in almost all sectors to ensure a smooth performance of the economy. However, the Classical school of thought considered labor and capital as the core factors of production, ignoring the role of technology, energy yield, and its use for economic activities. The Neo-Classical doctrine emphasizes the need for an increase in labor force, capital, and technological progress to enhance productivity and achieve sustainable economic growth (Stern, 2004).

Recent studies highlight the crucial importance of energy in promoting economic activities for advancing progress and development in emerging economies. As a driving force behind various industries and sectors, energy enables businesses to grow, innovate, and create new employment opportunities (Rezaei Sadr et al., 2022). Classical economic theory acknowledges the concept of resource scarcity. This means that natural resources are limited and when they are used to achieve growth objectives, they start to deplete, leading to changes in the natural environment. This phenomenon is known as environmental degradation (Simon & Kahn, 1984). Moreover, the extraction and utilization of new deposits of various types of energy resources can boost economic growth, provide employment opportunities, improve the standard of living by increasing per capita income, and increase the demand for environmentally friendly products (Osuntuyi & Lean, 2023).

Pakistan, with an economy valued at 271.05 billion dollars, contributes approximately 0.44 percent to the global GDP. The country's population stands at around 200 million, experiencing an average economic growth rate exceeding 4 percent over the past three years.

Journal of Business and Management Research
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Volume No:3 Issue No:2(2024)

Energy consumption is distributed among various sectors, with households accounting for 40%, industry 36%, transportation 33%, agriculture 12.2%, commercial sector 6%, and other government sectors 7.2%. Notably, only 3.5% of energy is derived from alternative and nuclear sources. Efforts to increase electricity production from renewable resources have seen the completion of several projects and ongoing initiatives. While household energy consumption decreased to 29% in 2008-09, the industrial sector's share increased to 43%. On average, energy usage per capita amounts to 204.94 kg of oil (The World Bank, 2015b).

Natural resources contribute 4.29% to Pakistan's GDP, out of which natural gas accounts for an average of 2.45%. Currently, only 81.03% of the population has access to electricity, with per capita consumption at 406 kWh. There are 95000 electrified villages, while 30000 villages still need to be electrified. The major sources of energy production in Pakistan are from coal, oil, and gas, while the rest comes from hydroelectricity and other imported energies. Pakistan emits an average of 68068.28 kilotons of CO_2 annually, with a per capita emission of 0.59 metric ton, making it the fourth most vulnerable country to climate change (The World Bank, 2015a). The manufacturing sector is affected by the scarcity of energy resources and environmental degradation, leading to inefficiency in production and reduced domestic supply. This creates inflationary pressure, a deficit in the balance of payments, and external debt due to imports, which drain foreign exchange reserves.

Environmental degradation damages the natural ecological system and creates a financial burden to reclaim it. The reduction in the assimilative capacity of the ecosystem leads to increased waste, disease spread, reduced labor efficiency, lower savings, and fewer funds for investment which adversely affect economic growth and development. Sustainable economic growth requires controlling environmental degradation while balancing energy production and consumption. Pakistan faces severe mismanagement among these variables, leading to unstable GDP growth, inflation, health issues, balance of payment deficit, high poverty rate, low standard of living, and deteriorating law and order situations. The energy crisis and environmental degradation worsen the situation. Unfortunately, the government hasn't taken significant measures to bridge these macroeconomic variables. The present study aims to examine these interrelationships and drive action towards a more sustainable future in Pakistan. In the current study, the variables under examination include Gross Domestic Product (GDP), Energy Consumption (EC), Environmental Degradation (ED), Gross Fixed Capital Formation (GFCF), Energy Price (EP), Population (POP), Industrialization (IN), and Number of Vehicles (NV).

Literature Review

(Canadell et al., 2007) Studies have shown that the growth rate of CO_2 in the environment is increasing at an alarming rate due to human social activities. The world's growth and carbon intensity have a significant impact on fossil fuel carbon emissions, as evidenced by a comparison of data from the 1990s to 2000-2006. The growth rate of carbon emission has increased from 1.3% to 3.3%, which reduces the efficiency of carbon sinks on land and sea. All of this indicates that the carbon cycle is generating stronger and earlier climate forcing than anticipated. (Ang, 2007). An analysis of pollutant emissions, energy use, and production in France from 1960 to 2000 used

Journal of Business and Management Research
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Volume No:3 Issue No:2(2024)

Cointegrating and VEC techniques. Results indicate a long-term relationship among these variables and a one-way causality from energy use growth to output growth in the short run.

Policies promoting sustainable energy use and production can minimize environmental impact while bolstering economic growth. (Wiedmann et al., 2007) evaluated various input-output models to gauge the environmental footprint of regional and international traded goods. From six models assessed based on data reliability and computational quality, the researchers identified one crucial aspect: the model's capability to account for global sector disaggregation in output recipe, land, energy consumption, and carbon emissions across different regions, sectors, and trade directions. (Burnett & Bergstrom, 2011) shared that a study was conducted in the USA to investigate the impact of clean technology on pollution emissions in the energy consumption and production sectors. The study also showed a relationship between the Kuznets curve and criteria pollutants and energy use in the USA. (Wang et al., 2011) discusses the relationship between industrialization, economic growth, mass energy production, and environmental degradation.

The ADF test was used to examine time series data, and the results showed that these variables have significant effects on pollution emissions and other related factors. (Tiwari, 2011) used a Granger approach in the VAR framework to examine the causality between energy use, carbon emission, and economic growth. The research found that energy use has a positive impact on both carbon emission and economic growth but has a negative impact on capital and population. (Zarenejad, 2012) conducted a study in Iran to investigate the interrelationships between the environment, energy consumption, population growth, and urban development. The data from the years 2001-2008 was analyzed using the STR model. The results showed that a 1% increase in energy use led to a 0.89% increase in per capita Co2 emissions. Additionally, a 1% increase in GDP per capita resulted in a 1.42% increase in Co2 emissions in Iran. (Audu & Okumoko, 2013) conducted a study on electricity demand and supply in Nigeria using VCEM approaches. The findings showed that there was an elastic demand between the price of elasticity and the income of consumers.

The study recommended that the government should take effective steps to address the problem of inefficiency and wastage of natural resources related to energy production and natural environment. (Raza et al., 2016) conducted a study using time series data from 1980 to 2010 to investigate the relationship between electricity consumption and economic growth in Pakistan, Bangladesh, Sri Lanka, and India. The panel data Cointegrating analysis reveals a positive and significant long-run relationship between energy consumption and economic growth.(Zambrano-Monserrate et al., 2016) study analyzed time series data from 1971 to 2011 for Brazil, focusing on the Environmental Kuznets Curve (EKC). Key variables studied were CO2 emissions, economic growth, energy consumption, and hydroelectricity production. Using an autoregressive distributed lag methodology, the study found a quadratic long-term relationship between economic growth and CO2 emissions. Energy consumption was positively associated with environmental degradation, while hydroelectricity production showed an inverse relationship. (Conrad & Cassar, 2014) carried out a cross-country study in Malta on decoupling economic growth and environmental degradation. Decoupling factors were gained in four sectors; i) energy intensity, climate change, air quality, ii) water, iii) waste and iv) land. The methodology employed sheds light on the relationship between the initial two components of the Driving force-Pressure-State-Impact-Response (DPSIR) framework. (Destek & Ozsoy, 2015) conducted a study in Turkey, where they used the Environmental Kuznets curve to examine the impact of energy consumption, globalization, and urbanization on the environment.

They found that all the variables were cointegrated, and the causality test results showed that economic growth and energy use contribute to environmental degradation. However, globalization was found to have a positive impact by reducing carbon emissions. (Raza et al., 2016) found a positive and significant long-term relationship between energy consumption and economic growth in Pakistan, Bangladesh, Sri Lanka, and India. (Shahbaz et al., 2016) conducted a study to explore the link between biomass energy consumption and economic growth in the BRICS region. They looked at data from 1991Q1 to 2015Q4 and used unit root and cointegration tests to examine the relationship between the variables. The findings suggest that the variables are interrelated and have effects on each other. (Zambrano-Monserrate et al., 2016) found that economic growth and CO emissions in Brazil have a quadratic long-run relationship. Energy use has a positive effect on environmental degradation, while hydroelectricity production has an inverse relationship. As highlighted in the meticulous study by (Osuntuyi & Lean, 2023), this inquiry delves into the intricate relationship between environmental sustainability, degradation, and their impact on economic growth.

In the 21st century, there has been a remarkable surge in attention towards environmental sustainability, driven by a pronounced escalation in environmental threats, the World Economic Forum (WEF), renowned for its authority, emphasizes a significant shift in the risk landscape as of 2021, revealing that four out of the top five global risks are now intricately linked to environmental concerns. (Azam et al., 2016) findings complicate our understanding of the link between carbon dioxide emissions and economic growth, especially in high-emitting nations. While the panel suggests a negative impact overall, individual country analyses reveal nuances; for instance, China shows a positive influence. This emphasizes the significance of considering country-specific contexts and policies in understanding environmental-economic dynamics. Tailored strategies are vital in navigating this complex nexus.

A meticulous examination of existing literature reveals a significant gap in understanding the relationship between environmental degradation and economic growth. Previous studies have often focused on a limited number of countries and employed a narrow perspective, primarily relying on carbon dioxide emissions as a measure of degradation. In contrast, our study takes a comprehensive approach, considering a diverse array of indicators such as total greenhouse gas emissions, methane, other greenhouse gases, and ecological footprint. Numerous studies worldwide have explored the relationship between energy use, economic growth, and environmental degradation, employing various determinants to analyze both short-term and long-term dynamics. In contrast to previous studies, our research concurrently investigates the interrelationship among these variables in both short and long terms. This study is groundbreaking in its examination of the relationship between energy use, economic growth, and environmental degradation in Pakistan. It introduces novel methods by simultaneously assessing their impacts on each other, filling a crucial gap in existing research. By including new determinants and employing a bidirectional approach, it offers a comprehensive analysis not previously explored in Pakistan. Unlike prior studies that mainly focus on the Kuznets hypothesis and unidirectional causality, this research reveals bidirectional relationships, particularly between energy consumption and economic growth. Drawing from the literature review, the following hypotheses and research questions have been formulated;

Hypotheses

1. H_0: Energy consumption has positive effect on economic growth in Pakistan.
   H_1: Energy consumption has negative effect on economic growth in Pakistan.
1. H_0: Economic growth has positive effect on energy consumption in Pakistan.
   H_1: Economic growth has negative effect on energy consumption in Pakistan.
2. H_0: Economic growth and energy consumption have positive effects on environmental degradation in Pakistan.
2. H_1: Economic growth and energy consumption have negative effects on environmental degradation in Pakistan.

Research Questions

This study aims to address the following questions:

1. Is there a relationship between economic growth, energy consumption, and environmental degradation in Pakistan?
2. What policy measures should be taken to address this issue in the present and future?

Research Methodology

To estimate the variables in the proposed model, time series secondary data i-e, time period from 1975 to 2016, shall be collected for all the variables. The generalized form of the model will be as:

$$GDP = F\ (EC,, GFCF, LO, PI, Co)$$

MODEL

This model studies the impact of Energy consumption (EC), Foreign Direct Investment (FDI), Gross Fixed Capital Formation (GFCF) and Public Debt (PD) on the Gross Domestic Product (GDP).

$$GDP_t = \alpha + \beta_i CE_t + \gamma_i FDI_t + \delta_i PoP_t + \lambda_i PD_t + \varepsilon_t \qquad (1)$$

Based on the Akaike information criteria (Annex 01), we choose the 5th assumption with a 3rd lag interval (Quadratic deterministic model). However, the Schwarz criteria suggest the 3rd assumption with a 2nd lag interval (Linear deterministic model). To test for cointegration, we'll use the Johansen trace test or maximum eigenvalue test based on the Akaike information criterion, selecting the 5th assumption and 3rd lag (Quadratic deterministic model).

Journal of Business and Management Research
ISSN:2958-5074 pISSN:2958-5066
Volume No:3 Issue No:2(2024)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.955171	215.3745	79.34145	0.0000
At most 1 *	0.663777	88.07355	55.24578	0.0000
At most 2*	0.469861	43.38431	35.01090	0.0051
At most 3	0.224090	17.36507	18.39771	0.0693
At most 4*	0.156183	6.962627	3.841465	0.0083

Table 1 Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob. **
None *	0.955171	127.3010	37.16359	0.0000
At most 1 * * At most 2	0.663777	44.68924	30.81507	0.0006
At most 3	0.469861	26.01924	24.25202	0.0289
At most 4 *	0.224090	10.40244	17.14769	0.3612

Table 2 Max-eigenvalue test indicates 3 cointegrating eq(s) at the 0.05 level

If the probability value is ≥ 5% or if the trace statistic values exceed critical values, we reject the null hypothesis of no cointegration, indicating that a long-term relationship exists among the variables. In this present model both standards of the Johansen cointegration test have rejected the null hypothesis, confirming the presence of cointegration.

ARDL, Error correction Model and Bound test

The ARDL model of the study regresses Gross Domestic Product (GDP) on Energy Consumption (EC), Foreign Direct Investment (FDI), Gross Fixed Capital Formation (GFCF), and Public Debt (PD) as follows:

$$\boldsymbol{GDP_t} = \alpha + \sum_{i=1}^{\tau} \beta_i \boldsymbol{EC_{t-i}} + \sum_{i=1}^{\tau} \delta_i \boldsymbol{GFCF_{t-i}} + \sum_{i=1}^{\tau} \lambda_i \boldsymbol{FDI_{t-i}} + \sum_{i=1}^{\tau} \lambda_i \boldsymbol{PD_{t-i}} + \sum_{i=1}^{\tau} \pi_i \boldsymbol{POP_{t-i}} + \varepsilon_t$$

Where $\boldsymbol{GDP_t}$the dependent Variable is ε_t is the error term and the rest are independent variables. The error correction term is added to the ARDL model:

Journal of Business and Management Research
ISSN:2958-5074 pISSN:2958-5066
Volume No:3 Issue No:2(2024)

$$\Delta \boldsymbol{GDP}_t = \alpha + \sum_{i=1}^{\tau} \beta_i \Delta \boldsymbol{CE}_{t-i} + \sum_{i=1}^{\tau} \gamma_i \Delta \boldsymbol{FDI}_{t-i} + \sum_{i=1}^{\tau} \delta_i \Delta \boldsymbol{GFCF}_{t-i} + \sum_{i=1}^{\tau} \lambda_i \Delta \boldsymbol{PD}_{t-i} + \sum_{i=1}^{\tau} \pi_i \Delta \boldsymbol{POP}_{t-i} + \varepsilon_t$$

VAR lag order selection criterion:

The GDP is regressed on energy consumption, Foreign Direct Investment, gross fixed capital formation, and Public debt; all criteria suggest using a 4th lag order **(Annex 02)** to capture the long-term relationship.

ARDL

The findings (Annex 03) reveal that energy consumption, public debt, and gross fixed capital formation all contribute positively to the gross domestic product (GDP) of Pakistan. However, foreign direct investment (FDI) is concluded to have a negative impact on energy consumption in the country. In the analysis of first differences, it is observed that energy consumption, public debt, and gross fixed capital formation still positively affect GDP, while the first difference in FDI and population continues to negatively influence GDP in Pakistan.

ARDL long Run form and Bound Test

Conditional Error Correction Regression
Levels Equation
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EC	-46.69752	46.99401	-0.906022	0.3406
PD	0.855169	0.257933	3.315465	0.0069
GFCF	-0.626575	1.357112	-0.461697	0.6533
FDI	-4.032176	4.547752	-0.886631	0.3942
POP	0.031893	0.019476	1.637544	0.1298

Null Hypothesis: No levels relationship

F-Bounds Test

Test Statistic	Value	Signif.	I(0)	I(1)
Asymptotic: n=100				
$F_K^{s\text{-statstic}}$	5.594648	10%	2.26	3.35
	5	5%	2.62	3.79
		2.5%	2.96	4.18
		1%	3.41	4.68

Journal of Business and Management Research
ISSN:2958-5074 pISSN:2958-5066
Volume No:3 Issue No:2(2024)

t-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
Asymptotic: n=100				
t-statistic	2.439451	10%	-2.57	-3.86
		5%	-2.86	-4.19
		2.5%	-3.13	-4.46
		1%	-3.43	-4.79

The F-bound statistic (5.59) exceeds the I(0) bound value (2.26), and the t-bound statistic (2.43) surpasses the I(0) bound value (-2.57). Thus, we reject the null hypothesis of no cointegration, confirming a significant long-term relationship among the variables.

ARDL Error correction Regression

The ECM methodology used to construct its initial model, envisioning an analytical framework that encapsulates these principles in the following manner:

$$\Delta GDP_t = \alpha(GDP_{t-1} - EC_{t-1}) + \beta(GDP_{t-1} - FDI_{t-1}) + \gamma(GDP_{t-1} - PD_{t-1}) + \sigma(GDP_{t-1} - GFCF_{t-1}) + \pi(GDP_{t-1} - POP_{t-1}) + \lambda_1 \Delta GDP_{t-1} + \lambda_2 \Delta EC_{t-1} + \lambda_3 \Delta PD_{t-1} + \lambda_4 \Delta FDI_{t-1} + \lambda_5 \Delta GFCF_{t-1} + \lambda_5 \Delta POP_{t-1} + \varepsilon_t$$

Where Δ represents differencing (t-1) represent the lag values of each variable, α measures the pace of adjustment, represented by the coefficient of the error correction term, and λ_i are coefficients for the lagged differences (Annexure 04).

Serial Correlation LM Test

Breusch-Godtrey Serial Correlation LM Test:

Null hypothesis: No serial correlation at up to 2 lags			
F-statistic	0.392300	Prob. F(2,9)	0.6865
Obs*R-squared	3.287678	Prob. Chi-Square(2)	0.1932

The probability of F (2, 9) shows that there is no serial correlation as the value 0.68 is above 0.05 (5%). Now to test the stability we will do the stability diagnosis.

Heteroskedasticity Test

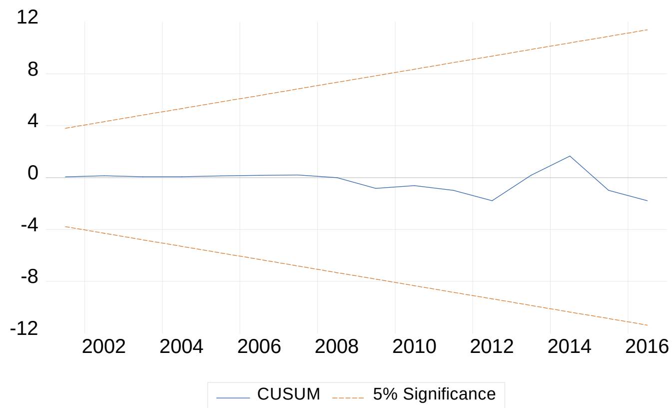
F-statistic	1.615870	Prob. F(27,13)	0.1827
Obs*R-squared	31.58778	Prob. Chi-Square(27)	0.2477
Scaled explained SS	4.553307	Prob. Chi-Square(27)	1.0000

Journal of Business and Management Research
ISSN:2958-5074 pISSN:2958-5066
Volume No:3 Issue No:2(2024)

The test indicates that our model's residuals have constant variance (homoscedasticity), as the probability value exceeds 5%. We conclude that there is no evidence of heteroskedasticity in our model.

Stability Test

The stability tests, particularly the CUSUM output criterion, indicate that our model remains consistent over time within the 5% range. This suggests that our parameter estimates adjust smoothly to evolving data patterns or dynamic system characteristics, affirming the stability of our model.



Discussion:

This model studies the impact of Energy consumption (EC), Foreign Direct Investment (FDI), Gross Fixed Capital Formation (GFCF) and Public Debt (PD) on the Gross Domestic Product (GDP). Developing nations prioritize industrialization and economic diversification to enhance productivity and generate employment opportunities. Sufficient energy provision is imperative for driving manufacturing operations, constructing essential infrastructure, and facilitating vital services like healthcare and education. The growth of energy-intensive sectors alongside investments in renewable energy sources contributes significantly to overall economic expansion. Addressing the intricate balance between economic development, energy efficiency, and environmental sustainability poses a formidable challenge, particularly for countries like Pakistan grappling with elevated levels of public debt, encompassing both external and domestic obligations.

Excessive debt burdens can jeopardize economic stability, crowd out investment opportunities, and impede resource allocation. Efficient debt management strategies, alongside the implementation of sound fiscal policies and structural reforms, are essential for safeguarding economic stability and fostering sustainable growth trajectories. Gross Fixed Capital Formation (GFCF), particularly in critical sectors like infrastructure and technology, serves as a catalyst for economic advancement by augmenting productive capacities and bolstering output levels.

Journal of Business and Management Research
ISSN:2958-5074 pISSN:2958-5066
Volume No:3 Issue No:2(2024)

Investments in fixed capital assets not only enhance productivity and efficiency but also bolster competitiveness, thereby propelling overall economic development. Embracing technological innovation and fostering an environment conducive to efficient investment practices are paramount for sustaining long-term economic growth trajectories. While Foreign Direct Investment (FDI) is typically viewed positively, it also harbors potential negative consequences, including resource depletion, exacerbation of social disparities, and cultural influence. Overreliance on FDI exposes countries to heightened vulnerabilities to global economic fluctuations and heightened financial volatility. Strategic planning and the adoption of effective policy frameworks are imperative to mitigate adverse impacts and harness the transformative potential of FDI for sustainable development agendas.

Recommendations:

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Volume No:3 Issue No:2(2024)

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Journal of Business and Management Research
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Volume No:3 Issue No:2(2024)

Annexure

Annexure 01

Selected (0.05 levelI*)Number of Cointegrating Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
Trace	No Trend	No Trend	No Trend	Trend	Trend
Max-Eig	4	4	4	4	3

Critical values based on Mackinnon-Haug-Michelis (1999)

Information Criteria by Rank and Model

Data Trend:	None	None	Linear	Linear	Quadratic
Rank or	No Intercept	Intercept	Intercept	Intercept	Intercept
Log Likelihood by Rank (rows) and Model (columns)					
0	-2650.663	-2650.663	-2635.060	-2635.060	-2626.083
1	-2609.368	-2602.365	-2587.215	-2586.906	-2577.992
2	-2583.001	-2574.824	-2559.707	-2559.284	-2550.731
3	-2561.365	-2552.397	-2548.782	-2546.418	-2537.997
4	-2550.723	-2541.717	-2540.002	-2536.661	-2533.379
5	-2550.435	-2539.682	-2539.682	-2532.203	-2532.203
Akaike Information Criteria by Rank(rows) and Model (columns)					
0	124.4494	124.4494	123.9563	123.9563	123.7713
1	122.9938	122.7146	122.1960	122.2282	121.9996
2	122.2326	121.9453	121.3817	121.4551	121.1968

Journal of Business and Management Research
ISSN:2958-5074 pISSN:2958-5066
Volume No:3 Issue No:2(2024)

3	121.6914	121.4138	121.3387	121.3683	121.0696*
4	121.6615	121.4287	121.3954	121.4261	121.3199
5	122.1133	121.8457	121.8457	121.7304	121.7304
			Schwarz Criteria by Rank (rows) and Model (columns)		
0	125.4734	125.4734	125.1850	125.1850	125.2049
1	124.4274	124.1891	123.8344	123.9074	123.8427
2	124.0757	123.8704	123.4296*	123.5849	123.4495
3	123.9441	123.7894	123.7962	123.9487	123.7319
4	124.3238	124.2548	124.2625	124.4570	124.3918
5	125.1851	125.1223	125.1223	125.2118	125.2118

Journal of Business and Management Research
ISSN:2958-5074 pISSN:2958-5066
Volume No:3 Issue No:2(2024)

Annexure 02 Lag Order

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-621.5507	NA	1.10e + 12	30.56345	30.77242	30.63955
1	-606.3448	25.96125	5.51e + 11	29.87048	30.12125	29.96180
2	-604.7588	2.630434	5.36e + 11	29.84189	30.13446	29.94843
3	-589.9609	23.82102	2.74e + 11	29.16883	29.50318	29.29058
4	-575.2458	22.96994*	1.41e + 11*	28.49980*	28.87595*	28.63677*

*Indicates lag order selected by the criterion
LR: seguential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ : Hannan-Quinn information criterion

Journal of Business and Management Research
ISSN:2958-5074 pISSN:2958-5066
Volume No:3 Issue No:2(2024)

Annexure 03 Dynamic regressors (4 lags, fixed): ED, PD, GCFC, FDI, POP

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GDP(-1)	0.874154	0.231765	3.771730	0.0031
GDP(-2)	-1.192639	0.205109	-5.814657	0.0001
GDP(-3)	3.315003	0.769078	4.310362	0.0012
GDP(-4)	-0.713227	0.969016	-0.736032	0.4771
EC	30.58502	39.93729	0.765826	0.4599
EC(-1)	-5.493440	43.45636	-0.126413	0.9017
EC(-2)	106.9410	45.19581	2.366171	0.0374
EC(-4)	-44.12064	55.35536	-0.797044	0.4423
PD	-27.98543	51.52092	-0.543186	0.5978
PD(-2)	0.523803	0.331172	1.581662	0.1420
PD(-3)	-1.048377	0.321508	-3.260814	0.0076
PD(-4)	0.453098	0.360607	1.256488	0.2350
GFCF	-0.729590	0.368183	-1.981596	0.0731
GFCF(-1)	-0.296365	0.426123	-0.695491	0.5012
GFCF(-2)	0.797931	0.781756	1.020690	0.3293
GFCF(-3)	-0.144469	0.757849	0.435559	0.6716
GFCF(-4)	-1.133449	0.795108	-0.181698	0.8591
FDI	0.953977	0.859809	-1.249662	0.2374
FDI(-1)	-3.348173	1.299849	-2.575817	0.02509
FDI(-2)	0.762385	2.224523	0.342718	0.7383
FDI(-3)	0.809983	1.839184	0.440404	0.6682
FDI(-4)	-5.183567	2.822412	-1.836574	0.0934
POP	12.13383	4.283528	2.832672	0.0163

Journal of Business and Management Research
ISSN:2958-5074 pISSN:2958-5066
Volume No:3 Issue No:2(2024)

POP(-1)	-0.119596	0.122716	-0.974573	0.3507
POP(-2)	0.330927	0.275760	1.200055	0.2553
POP(-3)	-0.383750	0.342121	-1.121678	0.2859
POP(-4)	0.169946	0.274022	0.620191	0.5478
C	-0.038456	0.126474	-0.304061	0.7668

Journal of Business and Management Research
ISSN:2958-5074 pISSN:2958-5066
Volume No:3 Issue No:2(2024)

Annexure 04 ECM Regression

Variable	Coefficient	Std. Error	t-Statistic
C	1250312	143500	0.0000
D(GDP(−1))	-1.40913	0.192661	0.0000
D(GDP(−2)}	-2.60177	0.16209	0.0000
D(GDP(−3))	0.713227	0.47350	0.1602
D(EC)	30. 850	17.29572	0.1047
D(EC(−1))	-34.8349	18.76533	0.0904
D(EC(−2))	72.10608	25.15777	0.0153
D(EC(−3))	27.98543	25.6125	0.2979
D(PD)	0.52380	0.14820	0.0047
D(PD(−1))	0.572856	0.211380	0.0203
D(PD(−2))	1.025955	0.152795	0.0000
D(PD(−3))	0.296365	0.20930	0.1845
D(GFCF)	0. 97931	0.41600	0.0814
D(GFCF(−1))	0.323941	0.37934	0.4113
D(GCC(−2))	0.179472	0.46220	0.7052
D(GFCF(−3))	-0.95397	0.53045	0.0996
D(FDI)	-3.34817	0.80733	0.0016
D(FDI(−1))	-7.76024	1.017194	0.0000
D(FDI(−2))	-6.95026	0.77309	0.0000
D(FDI(−3))	-12.1338	1.616810	0.0000
D(POP)	-0.11959	0.08243	0.1747
D(POP(−1))	0.25226	0.121386	0.0619
	-0.13149	0.115858	0.2805

Journal of Business and Management Research
ISSN:2958-5074 pISSN:2958-5066
Volume No:3 Issue No:2(2024)

D(POP(−2))	0.03845	0.062842	0.5530
D(POP(−3))	1.283291	0.183654	0.0000
CointEq(-1)*			