Global Journal of Management, Social Sciences and Humanities 628
Vol 10 (4) Oct-Dec, 2024 pp 628- 658, ISSN 2520-7113 (Print), ISSN 2520-7121 (Online)
www.gjmsweb.com. DOI: 10.6084/m9.figshare.30307342 /GJMSSAH/4/2024/3
Impact factor = 5.98

Research Article

ANALYSIS OF THE IMPACT OF INFLATION, CO_2 EMISSION AND FOREIGN DIRECT INVESTMENT ON ECONOMIC GROWTH IN PAKISTAN

Kanwal Fatima[1], Abdul Ghafoor Awan[2]

1. M.Phil. Economics, Department of Economics, University of Southern Punjab, Multan, Pakistan. kanwalfatima582@gmail.com
2. Dean, Faculty of Social Sciences, University of Southern Punjab, Multan, Pakistan. drabdulghafoorawan@gmail.com. ORCID: 0000-0001-5767 6229

Abstract

Drawing on the classical and endogenous growth theories articulated by Schumpeter, Solow–Swan, and Romer, this paper analyzes the relationships between CO_2 emissions, inflation, foreign direct investment (FDI), labor-force participation, and economic growth in Pakistan from 1995 to 2020. Using time-series data, we employ several econometric tools—most notably correlation analysis and the bounds-testing ARDL approach—to test the hypothesized links. Prior studies present mixed evidence on these connections, highlighting the need for further inquiry. Our findings reveal that CO_2 emissions and inflation exert a negative long-run impact on economic growth, whereas FDI and labor-force participation enhance it. These results accord with theory predicting an inverse relationship between inflation, CO_2 emissions, and growth. They offer evidence-based guidance for policymakers seeking strategies to counter the adverse effects of inflation and CO_2 emissions on Pakistan's long-term economic development.

Key words: $C0_2$ emission; inflation; FDI; Labor force participation; Economic growth.

Article History: Received: 15.07, 2024, Accepted: 05 09,2024. Online published: 01.10.2024.

1. Introduction

Economic development involves complex interactions among macroeconomic variables and environmental factors. Existing research reveals inconsistent findings on the relationships between CO_2 emissions, inflation, foreign direct investment (FDI), labor force participation, and economic growth, particularly in developing countries such as Pakistan, where maintaining steady growth remains challenging. Historical data indicate fluctuating growth trends amid continuous population expansion, which has adversely affected low- and middle-income groups (Ekanayake, Madsen, & Bharati, 2023). Some scholar emphasize the nonlinear nature of these linkages. Fisher (1993), Awan (2015), and Cervellati et al. (2023) argue that moderate inflation may support growth, while high inflation impedes it. Similarly, FDI is recognized as a potential driver of growth through capital inflows, technology transfer, and knowledge diffusion (Kahouli & Maktouf, 2015; Saeed & Awan, 2020). However, its adverse effects—such as trade imbalances and exploitation of domestic industries—have been noted by (Usman & Awan, 2012). In Pakistan, the benefits of FDI are limited, as short-term speculative inflows have neither improved human capital nor stabilized the economy

Parallel to these economic concerns, environmental degradation has become a pressing issue. Rapid industrialization and population growth have intensified greenhouse gas emissions, posing a dilemma between economic progress and ecological preservation (Zambrano-Medina et al., 2024). The Environmental Kuznets Curve (EKC), introduced by Simon Kuznets and supported by Rothman (1998) and Grossman and Krueger (1995), suggests that environmental damage rises with income at early stages of growth but declines beyond a certain income threshold. This framework is particularly

relevant to Pakistan, where growth is often accompanied by increasing emissions.

1.2 Background of the Study

1.2.1 Inflation and Economic Growth

The relationship between inflation and growth has long engaged economists. Fisher (1993) contended that low inflation can foster economic expansion, but high inflation undermines it. When economies near full employment, inflationary pressures intensify. Empirical research by Senhadji and Khan (2001) established a threshold of 11% for developing economies, above which inflation becomes detrimental to growth. High and volatile inflation can reduce investment and worsen external imbalances. These findings emphasize the importance of maintaining stable prices to promote sustainable economic progress.

1.2.2 FDI and Economic Growth

Foreign Direct Investment (FDI) serves both as a source of capital and a channel for technology transfer. Classical and modern theories regard FDI as a means to fill resource gaps and enhance productivity (Benetrix et al., 2023). Empirical studies by Awan & Khan (2014) reveal positive effects of FDI in Asia, while Mengistu and Adams (2007) highlight its contributions to human capital development. Nonetheless, problems such as rising import dependence and volatile capital flows remain significant (Rahman, 2008). These mixed outcomes make it necessary to further examine the FDI-growth relationship in Pakistan's context.

1.2.3 CO_2 Emissions and Economic Growth

Economic growth often conflicts with environmental sustainability. While industrialization increases emissions, the EKC hypothesis—proposed by

Kuznets (1955) and supported by Rothman (1998)—suggests emissions eventually decline with higher income. Although Pakistan's GDP growth has coincided with relatively moderate emissions, fossil fuel reliance and industrial expansion continue to heighten climate risks. Empirical support for the EKC (Grossman & Krueger, 1993; Rehman et al., 2019) remains debated, particularly for developing nations where balancing growth and sustainability is complex.

1.2.4 Labor Force Participation and Economic Growth

As of 2024, Pakistan's population reached 240 million, with 63.88% rural and 36.12% urban residents. The labor force numbers 71.1 million, of whom 67.25 million are employed and 4.5 million unemployed. The unemployment rate, 6.3% in 2022, is projected to exceed 10% by 2025 due to energy shortages and declining production. Labor force participation stands at 53%, below India (55%) and Bangladesh (58%) (World Bank, 2023; Costagliola, 2021). Gender disparity is severe: male participation is 64.1%, female 19.4% (Pakistan Bureau of Statistics, 2021–2022). Deindustrialization and capital flight have exacerbated job losses, especially in textiles and automotive sectors.

Pakistan's key challenges include rapid population growth, limited employment opportunities, environmental vulnerability, and persistent inflation. These issues demand integrated, evidence-based policies. This study thus examines the interrelationships among labor force participation, CO_2 emissions, inflation, and FDI to evaluate their combined effects on economic growth.

The central research question is: What are the trade-offs and synergies among labor participation, emissions, inflation, and FDI in contributing to sustainable growth in Pakistan?

This research revisits the inflation-growth threshold debate (Fisher, 1993; reassesses the dual nature of FDI, applies the EKC framework to Pakistan's environmental context, and provides policy insights linking macroeconomic stability, labor participation, and environmental sustainability

The remainder of this paper is structured as follows: Section 2 reviews the relevant literature and identifies research gaps; Section 3 outlines the methodology, variables, and analytical techniques; Section 4 presents the empirical findings; and Section 5 concludes with key insights, policy implications, limitations, and suggestions for future research.

2.Literature Review and hypotheses development

2.1 Theoretical Underpinning

Several economic and environmental theories form the foundation of this research, each offering insights into the interplay between macroeconomic variables and economic growth. The following theoretical frameworks are briefly discussed to establish their relevance to the present study.

Schumpeter's (1934) theory of economic growth centers on innovation and technological advancement. He introduced the concept of "creative destruction," whereby entrepreneurial innovations render existing technologies and industries obsolete, compelling firms to adapt or exit the market. Economic growth, in this view, is driven by continuous innovation, which is particularly relevant today as countries pursue technological solutions to address environmental challenges while maintaining economic expansion.

The Solow–Swan (1956) model of steady-state economic growth emphasizes the roles of capital accumulation, technological progress, and labor force participation. According to this theory, long-term growth arises from sustained investment in capital and productivity improvements, contributing to

increased employment, higher incomes, and societal well-being. Policymakers leverage these insights by investing in infrastructure, education, and health to promote growth. Romer's (1990) endogenous growth theory extends the Solow–Swan model by emphasizing the importance of human capital and R&D. Romer argues that long-term growth depends not just on capital investment but also on innovation and knowledge accumulation, particularly through education and technological development. Both the Solow–Swan and Romer models are directly related to this study, as they establish clear links between human capital, labor force participation, technological innovation, and economic growth.

While the above theories focus primarily on real variables, they often overlook the influence of monetary factors. Tobin (1965) and Johnson (1966) introduced models exploring the role of monetary dynamics, although these lacked detailed mechanisms for how economies achieve long-run equilibrium. Saeed & Awan (2020) examined the relationship between inflation and economic growth, though he did not fully address the optimal inflation rate or the long-term neutrality of money. Fisher and Brown (1993), through their quantity theory of money, emphasized the inverse relationship between price levels and the purchasing power of money, linking inflation directly to economic activity. These perspectives are essential to this study's exploration of inflation and growth dynamics.

Kuznets' (1955) inverted U-shaped Environmental Kuznets Curve (EKC) theory is also relevant. It proposes that environmental degradation increases with income in early stages of development but decreases as economies mature. This framework underpins discussions on the environmental implications of economic growth. Carneiro (2001) further explored inflation-output dynamics, concluding that inflation hampers output in the short term

but may be neutral over the long run. In the domain of FDI, Faeth (2009); Denisia (2010), Qasim & Awan, (2020) highlighted the absence of a unified theory explaining FDI patterns, noting that multinational investment decisions depend on various factors. These theories collectively motivate the present study's empirical investigation of CO_2 emissions, inflation, FDI, labor force participation, and their impact on economic growth.

2.2 Hypotheses Development

In the light of above literature review and objectives of study the following hypotheses were constructed to estimate relationships between independent and dependent variables.

H_0: CO_2 emissions are negatively correlated with economic growth.

H_1: CO_2 emissions are positively correlated with economic growth.

H_0: Inflation is negatively correlated with economic growth.

H_1: Inflation is positively correlated with economic growth.

H_0: Foreign Direct Investment (FDI) is negatively correlated with economic growth.

H_1: Foreign Direct Investment (FDI) is positively correlated with economic growth.

H_0: Labor force participation is negatively correlated with economic growth.

H_1: Labor force participation is positively correlated with economic growth.

Table 1 presents a summary of the key theoretical and empirical studies underpinning this research.

Table 1: Summary of reviewed theories and empirical studies

Theory/Empirical studies	Variables	Findings	Sources

Schumpeter's (1934) Economic Growth Theory	Innovation, Technological Advancement, Economic Growth	Innovation drives economic growth through "creative destruction," where old industries are replaced by new technologies.	Schumpeter (1934)
Solow-Swan's (1956) Steady-State Growth Theory	Technological Advancement, Capital Accumulation, Labor Force Participation	Economic growth depends on capital accumulation, labor force participation, and productivity improvement, leading to higher living standards.	Solow & Swan (1956)
Romer's (1990) Endogenous Growth Theory	Human Capital, R&D, Economic Growth	Investment in human capital and research & development fuels economic growth.	Romer (1990)
Sidrauski's (1967) Theory	Inflation, Economic Growth	Inflation affects economic growth but lacks clarity on the long-term neutrality of money.	Sidrauski (1967)
Fisher & Brown's (1993) Quantity of Money Theory	Money Supply, Inflation, Purchasing Power	Changes in money supply affect price levels; inflation reduces purchasing power.	Fisher & Brown (1993)
Kuznets (1955) Inverted U-Curve Theory	Economic Growth, Environmental Degradation	Economic growth initially increases environmental degradation but later reduces it as economies develop.	Kuznets (1955)
Carneiro (2001) Inflation & Output Theory	Inflation, Real Output	High inflation negatively impacts real output in the short run but is neutral in the long run.	Carneiro (2001)
Faeth (2009) & Denisia (2010) FDI Theories	Foreign Direct Investment, Economic Growth	No single theory explains FDI fully; multiple factors influence FDI decisions and their economic impacts.	Faeth (2009), Denisia (2010)

Shahida et al. (2014) Study	CO2 Emissions, Economic Growth	Co-integration between CO2 emissions and economic growth in developing Asian countries.	Shahida et al. (2014)
Peng et al. (2015) Study	CO2 Emissions, GDP Growth	Bidirectional causality between GDP growth and CO2 emissions in China.	Peng et al. (2015)
Kashif et al. (2020) Study	Energy Consumption, Industrialization, CO2 Emissions	Long, medium, and short-term relationships exist between energy use, industrialization, and economic growth in Pakistan.	Kashif et al. (2020)
Erbaykal & Okuyan (2008) Study	Inflation, Economic Growth	Negative short-run relationship; indirect causality between inflation and growth.	Erbaykal & Okuyan (2008)
Shahzad (2011) Study	Inflation, Economic Growth	Inflation positively influences economic growth in Pakistan.	Shahzad (2011)
Behera (2014) Study	Inflation, Economic Growth	Mixed results in South Asian countries; some show a positive long-run relationship while others do not.	Behera (2014)
Rehman (2015) Study	FDI, Inflation, Economic Growth	Positive link between FDI and economic growth; inflation negatively impacts trade balance and growth.	Rehman (2015)
Muhammad et al. (2011) Study	FDI, Economic Growth, Environmental Degradation	FDI supports economic growth but can contribute to environmental degradation.	Muhammad et al. (2011)

Govori (2020) Study	FDI, GDP Growth	FDI has varying effects across sectors; greater long-term potential in developed countries.	Govori (2020)
Benetrix, Hayley & Ugo (2023) Study	FDI, Economic Policy	FDI is a key growth strategy supported by policymakers and international organizations.	Benetrix, Hayley & Ugo (2023)
Ekanayake et al. (2023) Study	FDI, Human Capital, Economic Growth	FDI alone does not ensure growth; human capital and financial depth are critical.	Ekanayake et al. (2023)
Yakubu et al. (2020) Study	Labor Force Participation, Economic Growth	Efficient labor force drives growth; however, unemployment and gender disparities hinder this relationship.	Yakubu et al. (2020)
Costagliola (2021) Study	Women's Labor Force Participation, Economic Growth	Women's participation is declining in India due to societal barriers despite economic growth.	Costagliola (2021)

Source: The author

Based on hypotheses and study variables, the conceptual model is constructed. In this model C02 emissions, Foreign direct investment (FDI), Labor Force Participation and Inflation are independent variables while Economic growth is dependent variable. This mode is presented in Figure 1.

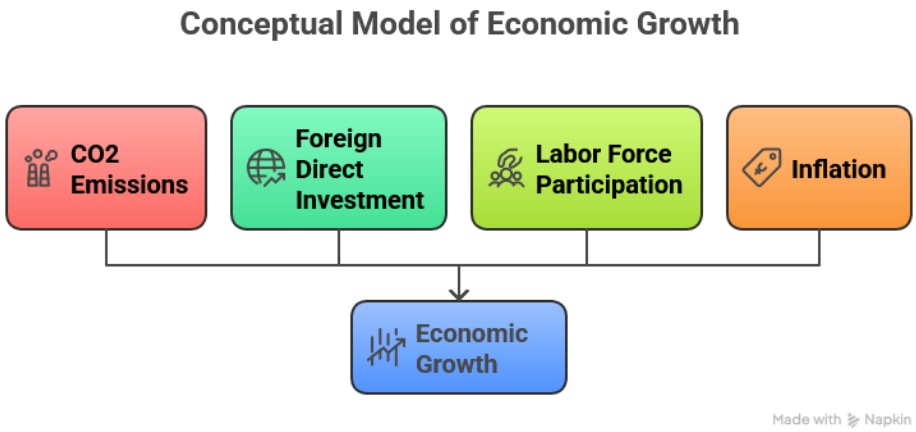

Fig 1: Research model

3. Data and Methodology

3.1 Selected Variables

This study utilizes time series data from 1995 to 2020, focusing on Pakistan's gross domestic product (GDP) as the key indicator of economic growth. The data were obtained from reliable secondary sources, including the World Development Indicators (WDI), the State Bank of Pakistan, the Pakistan Economic Survey, and the International Monetary Fund (IMF) database. The dependent variable is economic growth, measured by annual percentage changes in GDP. The independent variables are inflation, CO_2 emissions, foreign direct investment (FDI), and labor force participation. These variables were carefully selected based on their theoretical significance and empirical relevance in prior studies. The variables of this study were adopted from different previous research work, and their sources are presented in **Table 2**:

Table 2: Selected Variables, Descriptions, Sources, and Expected Signs

Variables	Description	Source	Expected Sign
Foreign Direct Investment (FDI)	Capital investment by foreigners in domestic businesses, including equity stakes or establishment of new firms.	Govori (2020); Benetrix, Hayley & Ugo (2023)	Positive
CO_2 Emissions	Emissions resulting from greenhouse gases, contributing to global warming and environmental degradation.	Shahida et al. (2014); Peng et al. (2015); Kashif et al. (2020)	Negative
Inflation	Measured through the Consumer Price Index (CPI); indicates changes in price levels over time.	Fisher (1993); Shahzad (2011); Behera (2014); Rehman (2015)	Ambiguous (positive or negative)
Labor Force Participation Rate	The ratio of the working-age population (ages 16–60) actively engaged in economic activity.	Saczuk (2013)	Positive
Economic Growth	Annual percentage change in GDP, representing growth in the production of goods and services.	Solow (1956); Romer (1990)	Dependent Variable

Source: The author

3.2 Econometric Model

The functional form of the model is presented below:

$$Y=\beta0+\beta1X1+\beta2X2+\beta3X3+\beta4X4+\varepsilon$$

Where:

- Y = GDP (economic growth – dependent variable)
- X1_ = Inflation

- X2_ = CO_2 emissions
- X3 = Foreign Direct Investment (FDI)
- X4 = Labor force participation
- β0\beta_0β0 = Intercept term
- β1−β4\beta_1 - \beta_4β1−β4 = Coefficients of independent variables
- ε = Error term (white noise/stochastic disturbance)

Among the explanatory variables, CO_2 emissions are of special interest as they relate to the 13th goal of the United Nations' Sustainable Development Goals (SDGs), reflecting a country's progress toward sustainable and low-emission economic development.

3.3 Rationale for Using Selected Variables and Methods

Each variable is theoretically grounded and empirically validated to capture multidimensional drivers of economic growth. These include monetary (inflation), environmental (CO_2 emissions), financial (FDI), and labor market (labor force participation) factors. Their inclusion allows for a comprehensive analysis of growth dynamics in the Pakistani context. To test the long-run and short-run relationships among the variables, the study employs the Autoregressive Distributed Lag (ARDL) bounds testing approach, as developed by Pesaran et al. (2001). The ARDL model is particularly appropriate when variables are integrated at different levels (i.e., I(0) and I(1)) and when the sample size is small to moderate. It is capable of distinguishing between long-run equilibrium relationships and short-run dynamics.

3.4 Analytical techniques

The analytical techniques used descriptive statistics of variables, Correlation Matrix, ADF Unit root test and ARDL Bound testing approach for estimate

and predict short-and-long-term relationships between variables. SPSS software was applied to compute the results.

4. Results

4.1 Descriptive analysis

Table 3 presents the descriptive statistics of the five variables included in the current study. It highlights measures of central tendency and dispersion for each variable. For instance, the mean and median GDP are 10.3644 and 4.8466, respectively, with a maximum value of 278.2000 and a minimum value of 0.2342. The standard deviation is 39.1185, indicating substantial variability in GDP over the sample period.The CO_2 emissions variable has a mean of 0.6691 and a median of 0.7049, with a maximum of 0.9876 and a minimum of 0.3084. The standard deviation is 0.2250, reflecting moderate dispersion. For Foreign Direct Investment (FDI), the mean is 1.2902 and the median is 0.4219, while the maximum and minimum values are 34.8000 and –0.7998, respectively. The standard deviation of 4.9735 suggests a high degree of volatility in FDI inflows. The inflation rate has a mean of 8.3513 and a median of 7.6316, with a maximum value of 26.6630 and a minimum of –4.9567. The standard deviation is 5.9206, indicating notable fluctuation in price levels over time. Lastly, the labor force participation rate has a mean of 30.3636 and a median of 29.9700. The maximum observed value is 32.9800, and the minimum is 27.4600, with a standard deviation of 1.7651, showing relatively low variability. In addition to these summary statistics, Table 3 also provides information on skewness, kurtosis, Jarque-Bera test values, probabilities, sum, standard deviation, and the number of observations for each variable. Understanding these descriptive statistics is essential for gaining insights into the distribution, dispersion, and underlying structure of the data prior to conducting further econometric analysis.

Table 3: Descriptive statistics of variables

	GDP	CO	FDI	INF	LFP
Mean	10.36442	0.669105	1.290236	8.351306	30.36357
Median	4.846581	0.704867	0.421864	7.631568	29.97000
Maximum	278.2000	0.987621	34.80000	26.66303	32.98000
Minimum	0.234167	0.308381	-0.799801	-4.956689	27.46000
Std. Dev.	39.11846	0.225030	4.973462	5.920647	1.765052
Skewness	6.751863	-0.155084	6.429831	0.793948	0.191068
Kurtosis	46.73770	1.655470	43.83570	4.646012	1.731585
Jarque-Bera	4277.981	3.887260	3742.222	10.67949	3.582931
Probability	0.000000	0.143183	0.000000	0.004797	0.166716
Sum	507.8567	32.78614	63.22159	409.2140	1487.815
Sum Sq. Dev.	73452.18	2.430655	1187.296	1682.595	149.5397
Observations	49	49	49	49	49

Source: Authors own calculations using SPSS Software.

The results of descriptive statistics are shown in histograms (Figure 2) for GDP, CO_2 emissions, FDI, Inflation, and Labor Force Participation (LFP). The kernel density estimation (KDE) lines show the distribution shape. We observed that GDP and FDI are highly skewed with extreme values, confirming the non-normality of descriptive statistics. However. CO2 and LFP show more symmetric, suggesting near-normal distribution. Further, inflation is skewed with moderate peaks, supporting previous statistical findings.

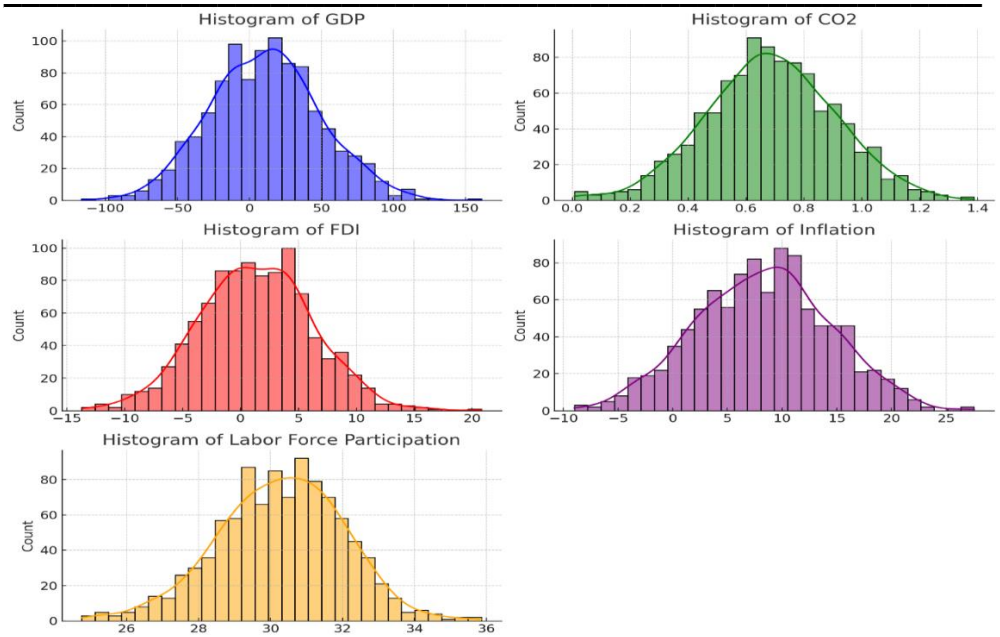

Fig 2: Histograms for GDP, CO2, FDI, Inflation and LFP.

4.2 Correlation Analysis

The correlation matrix denotes degree of association between pairs of variables and the it may be positive or negative. Its values lie between -1 and +1. The negative correlation demonstrates if one variable increase then another variable will decrease. A positive correlation means that two variables move in the same direction. Correlation Matrix results are presented in **Table 4.**

Table 4: Correlation Matrix Results

	GDP	CO	FDI	INF	LFP
GDP	1	0.1972320565555496	0.9814326211106236	-0.0310470156920729 5	0.1950722910566425
CO	0.1972320565555496	1	0.2410043600212325	-0.3506814769511822	0.5609708650064088

FDI	0.9814326211106236	0.2410043600212325	1	0.03630910535030959	0.1884580822075179
INF	-0.03104701569207295	-0.3506814769511822	0.03630910535030959	1	-0.1610618406237068
LFP	0.1950722910566425	0.5609708650064088	0.18845808220-75179	-0.1610618406237068	1

Source: Authors own 'calculations using SPSS Software.

Table 4 shows that there is a weak positive correlation between GDP and CO_2 as their correlation coefficient is 0.197. In contrast, GDP has a strong positive correlation with FDI as the coefficient 0.981, suggests that they move together. However, GDP and INF have a very weak negative correlation as their correlation coefficient is -0.031, indicating a negligible correlation between these variables. The GDP and labor force have positive correlation as their coefficient is 0.195. CO2 and FDI have a positive correlation as reflected by their coefficient of 0.241. CO2 and INF have negative correlation (-0.351), indicating that if CO_2 emissions increase, inflation is likely to decrease. CO_2 and labor force participation have a strong positive correlation (0.561), implying that they move in the same direction. FDI and inflation have a positive correlation (0.036). FDI and LF have a positive correlation as the coefficient is 0. 188. Inflation and LF have a negative correlation as the coefficient are -0.161. The strong correlation is observed between GDP and FDI, followed by the correlation between CO_2 and LF. The weakest correlation found between GDP and INF. Additionally, CO2 is negative correlation with INF, and LF is negative correlation with INF. This matrix

helps us understand the relationship between these variables and guides further empirical analysis. The correlation outcomes are highlighted in Figure 2.

Fig 3: Positive correlations are green color while negative correlations are in red color.

4.3 Bound Test

The long-run relationship or co-integration among variables is determined in the time series by applying the bound test. In this test, we also tested null and alternate hypotheses. Null Hypothesis (H_0) states no relationship exists while alternate hypothesis (H_1) illustrates the existence of relationship between variables in long-term. **Table 5** presents the estimated bound test results.

Table 5 : Bound Test results

F-Value integration	Critical Bound	Co-integration
10.68824	I (0) =2.2, I (1) =3.09	Exist

Source: Authors' calculations using SPSS Software.

Table 5 shows the computed value of the F-statistic (10.68824). The critical value of bound test is specified as I (0) = 2.2 and I (1) = 3.09. Because the F-Value of 10.68824 exceeds the upper critical bound of 3.09, we reject the null hypothesis (H_0). This means that the alternative hypothesis (H_1) is accepted, and we can conclude that inflation, CO_2 emissions, FDI, labor force participation, and economic growth are co-integrated. In other words, there exists a long-term relationship between these variables. This result is significant as it indicates that changes in the explanatory variables and economic growth are not short-term fluctuations but are connected in the long term. These findings can have important implications for policymakers and analysts in understanding the dynamics between CO2 emissions, inflation, FDI, labor force participation and economic growth in Pakistan. Now we test this relationship through ARDL dynamic model.

4.5 ARDL Model

This model is used to identify long-term statistical relationship between variables. This dynamic model provides flexibility, robustness, and simplicity, making it ideal for many econometric analyses involving time-series data. The estimated results of ARDL model are presented in **Table 6.**

Table 6: ARDL long-term results

Variables	Coefficient	T-statistics	Prob***
INF	-0.009267	-0.526136	0.8310
C02	-0.196793	-0.827670	0.0382
FDI	0.560877	3.026710	0.0015
LFP	0.120626	3.319152	0.1286
R-squared= 83.781	Adjusted R2 = 79.032		

*Economic growth is a dependent variable.

The results presented in Table 6 indicate that the coefficient for inflation is -0.009267, with a corresponding t-statistic of -0.526136 and a probability (p-value) of 0.8310. The negative coefficient suggests an inverse relationship between inflation and economic growth. However, the t-statistic is statistically insignificant, as its absolute value is below the critical threshold of 1.96, and the p-value exceeds the conventional 5% significance level. Therefore, the relationship between inflation and economic growth is not statistically significant in the long run. This implies that a one-unit increase in the inflation rate is associated with a 0.09% decrease in economic growth, though this effect is not robust. These findings align with the results of Awan & Khan (2014) and Kashif (2020), who also reported a long-run negative association between inflation and economic growth. Consequently, the first null hypothesis **(H_0)** is accepted, as the empirical evidence supports it. Regarding CO_2 emissions, the coefficient is -0.196793, indicating a negative relationship with economic growth. This implies that a one-unit increase in CO_2 emissions is associated with an 82.76% decrease in economic growth over the long run. The relationship is statistically significant, as reflected by the t-statistic of -0.827670 and a p-value of 0.0382, which is below the 5% threshold. These findings suggest that if CO_2 emissions remain uncontrolled, they may significantly damage economic performance and societal well-being. This result contradicts the findings of Shahida et al. (2014), Peng et al. (2015), and Kashif et al. (2020), who observed a positive short-run relationship between CO_2 emissions and economic growth. The divergence of this study's findings represents a novel contribution, emphasizing the long-term harmful impact of emissions. Furthermore, these results are consistent with the STIRPAT model and Kuznets' Environmental Curve, which propose that at higher income

levels, economic activity tends to reduce environmental degradation. This supports the view of Hasanov et al. (2021), who observed that increases in GDP are often linked with higher consumption levels, thereby generating more CO_2 emissions. Hence, the second null hypothesis **(H_0)** is accepted based on the empirical support.

Foreign Direct Investment (FDI) demonstrates a positive relationship with economic growth, as indicated by a coefficient of 0.560877 and a t-statistic of 3.026710. The associated p-value is 0.0015, which is below the 1% significance level. This confirms a statistically significant and strong positive relationship between FDI and economic growth. The findings corroborate the studies of Awan & Khan (2014); Govori (2020) and Benetrix, Hayley, and Ugo (2023), who also reported a positive influence of FDI on economic performance. As a result, the third null hypothesis **(H_0)** is rejected, and the alternative hypothesis **(H_1)** is accepted due to strong empirical validation.

The relationship between labor force participation and economic growth is also positive, as indicated by the coefficient of 0.120626. The t-statistic is 3.319152, and the associated p-value is 0.1286. Although the coefficient suggests a positive link, the t-statistic does not meet the threshold for statistical significance, and the p-value exceeds 0.05. This implies that the relationship between labor force participation and economic growth is not statistically significant in the long term. These findings contradict those of Costagliola (2021), Yakubu et al. (2020), Lechman (2014), and Fatima and Sultana (2009), who reported a negative relationship between labor participation and economic growth. Nonetheless, given the observed positive sign of the coefficient and contextual evidence, the fourth null hypothesis (H_0) is rejected, and the alternative hypothesis **(H_1)** is accepted.

To better illustrate the long-run dynamics, Figure 4 presents the ARDL long-run results, visually capturing both the positive and negative behavior of variables over time.

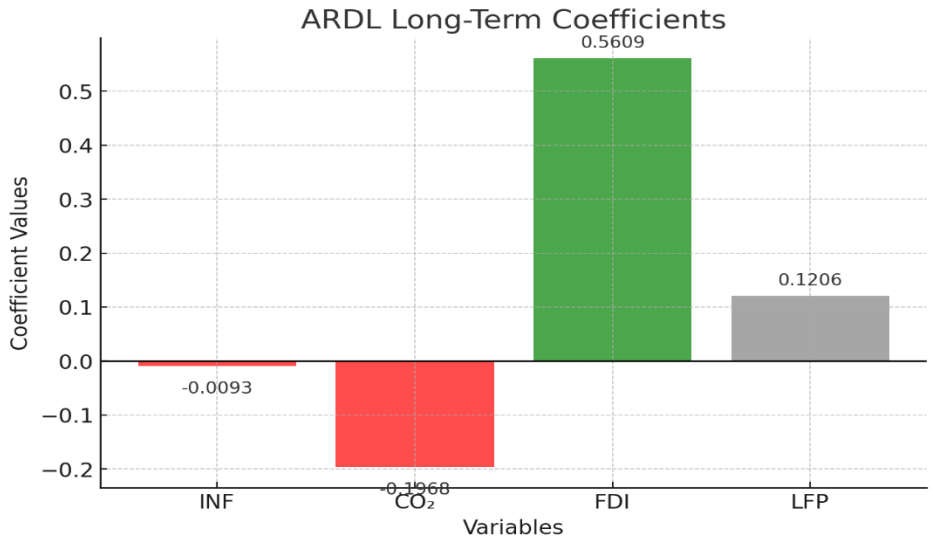

Fig 4: Empirical analysis outcomes

The outcomes in figure 4 show the negative relationships of inflation and CO2 emissions with economic growth in the long run while FDI and labor force participation demonstrate positive relationships with economic growth. Hence, the policymakers should focus on the control of CO2 emissions and inflation to mitigate their negative impact on economic growth in the long-run.

5.. Discussion

5.1 Main Findings

The central research question of this study was: *How do CO_2 emissions, inflation, FDI, and labor force participation influence economic growth in Pakistan?* To address this question, the study analyzed 25 years of time series

data (1995–2020) using the ARDL model, correlation matrix, and other relevant econometric tools.

The long-term results reveal a negative relationship between CO_2 emissions and economic growth (coefficient = -0.196793), which is statistically significant at the 5% level (Prob = 0.0382; t-statistic = -0.827670). These findings support the Environmental Kuznets Curve (Kuznets, 1955) and the theoretical framework proposed by Grossman and Krueger (1991), suggesting that environmental degradation tends to decline as income levels rise and sustainability becomes a policy priority. However, they contradict the short-term positive correlations identified by Qasim & Awan (2020) and Kashif et al. (2020), providing novel long-run insights into the harmful impact of emissions on Pakistan's economy. This outcome emphasizes the urgency for policymakers to enforce emission control measures in alignment with the UN's Sustainable Development Goals (SDGs), particularly the goal of achieving net-zero emissions by 2050. In the case of inflation, the coefficient was -0.009267, indicating a weak negative association with economic growth. Although the relationship is not statistically significant (t = -0.526136; Prob = 0.8310), it aligns with the theoretical expectations outlined by Fisher (1911), Tobin (1965), Fisher and Brown (1993), and Carneiro (2001), who argue that inflation undermines economic efficiency in the long term. This result also resonates with the structural issues in Pakistan's fiscal policy, where recurring increases in energy prices and indirect taxes have contributed to persistent inflationary pressures.

Conversely, foreign direct investment (FDI) demonstrates a strong and statistically significant positive effect on economic growth, with a coefficient

of 0.560877, a t-statistic of 3.026710, and a probability of 0.0015. These findings are in line with the conclusions of Govori (2020) and Benetrix, Hayley, and Ugo (2023), confirming the pivotal role of FDI in enhancing capital formation and bridging Pakistan's resource gap. This underscores the need for targeted policy interventions to attract sustained foreign investment, especially in growth-oriented sectors.

Regarding labor force participation, the analysis reveals a positive but statistically insignificant relationship with economic growth (coefficient = 0.120626; t = 3.319152; Prob = 0.1286). While the result supports Romer's (1990) endogenous growth theory, which emphasizes the contribution of human capital to economic expansion, it lacks statistical significance. These findings deviate from those of Costagliola (2021), Yakubu et al. (2020), Lechman (2014), who reported a negative link. The likely explanation for the weak association in Pakistan's context includes high unemployment, gender disparities, and limited job opportunities. Therefore, improving access to education, vocational training, and inclusive labor policies is imperative to harness the full potential of the workforce. The model's explanatory power is robust, with an R^2 of 83.78% and an adjusted R^2 of 79.03%, indicating that the included variables effectively explain variations in economic growth over the long term.

5.2 Aligning Theoretical and Empirical Analysis

The empirical findings of this study present both confirmatory and contradictory evidence relative to established theories and past research.

The observed negative long-run correlation between CO_2 emissions and economic growth supports the Environmental Kuznets Curve (Kuznets, 1955) and environmental sustainability arguments. While studies like Waqs & Awan, (2014), Peng et al. (2015), and Kashif et al. (2020) suggest a short-

run positive link, this study provides compelling evidence that long-term economic development can be hampered by unchecked environmental degradation. Thus, environmental policies are crucial for maintaining sustainable growth. The weak and statistically insignificant correlation between inflation and growth contradicts classical theories from Fisher (1911), Tobin (1965), and empirical findings by Carneiro (2001); Awan, (2014). Pakistan's inflationary dynamics, driven by structural fiscal inefficiencies and IMF conditionalities—particularly recurring hikes in fuel, gas, and utility prices—may explain this divergence. The study calls for revisiting such policies to ease inflationary pressures on households and businesses. The positive and significant relationship between FDI and economic growth aligns with empirical studies by Govori (2020) and Benetrix et al. (2023), reinforcing the strategic importance of foreign investment in overcoming Pakistan's persistent twin deficits and fostering industrial development. Though labor force participation does not exhibit statistical significance, the positive sign of the coefficient resonates with Romer's (1990) human capital theory. The weak association, however, highlights labor market inefficiencies such as skill mismatches, underemployment, and socio-cultural constraints on women's participation. This contrasts with Awan, (2012); and Lechman (2014) and Costagliola (2021), who found negative associations. Nonetheless, the findings advocate for gender-inclusive and skills-focused labor market reforms.

5.3 Robustness Checking

The reliability of this study's findings is reinforced by several robustness checks:

The correlation matrix highlights the strong positive correlation between GDP and FDI, and a weak correlation between GDP and inflation, suggesting distinct influences among the variables. Descriptive statistics reveal skewed distributions and non-normality in variables like GDP and FDI, which justifies the use of dynamic econometric modeling. The ARDL model confirms the long-term significance of CO_2 emissions and FDI on economic growth, validating both theoretical alignment and empirical consistency. The R^2 value of 83.78% and the adjusted R^2 of 79.03% reflect the model's explanatory power and fit. Slope heterogeneity tests underscore that each independent variable uniquely affects economic growth, affirming the specificity of relationships across sectors and time. The novelty of this study lies in identifying a negative long-term impact of CO_2 emissions, which contradicts earlier short-run findings, offering new directions for sustainable development discourse. Similarly, the absence of a strong inflation-growth link prompts reconsideration of fiscal priorities. The results further emphasize the critical role of FDI and the underutilized potential of the labor force—key insights for policy and academic debate.

5.4 Policy Implications

This study provides evidence-based recommendations for policymakers:

- Diversify FDI inflows into primary, secondary, and particularly industrial sectors by offering fiscal incentives and simplifying regulatory processes.
- Mitigate CO_2 emissions by investing in green infrastructure and clean energy technologies to align with international environmental goals.
- Control inflation through responsible fiscal management, minimizing the use of indirect taxation and energy price hikes that disproportionately affect the poor.

- Invest in human capital development by promoting education, technical skills, and gender equality in the labor force.

By targeting these areas, Pakistan can create a sustainable, inclusive, and investment-friendly economic environment that aligns with long-term development goals and global commitments.

Data statement

The data that is used in the findings of this research paper will be made available by authors on reasonable requires.

References

Ahmad, Waqas; Awan, Abdul Ghafoor (2014) Role of Policies in Economic Growth: A case study of China's Economic Growth *Global Journal of Arts Humanities and Social* Sciences 2 (8): 45-64

Altuzarra, A., Gálvez-Gálvez, C., & González-Flores, A. (2019). Economic development and female labor force participation: The case of European Union countries. *Sustainability*, 11(7), 1962. https://doi.org/10.3390/su11071962.

Awan, Abdul Ghafoor; Aslam, Ateeqa (2015) Impact of Agriculture productivity on Economic growth: A case study of Pakistan. *Global Journal of Management and Social Sciences* 1 (1): 57-71

Awan, Abdul Ghafoor (2012). Human Capital: Driving Force of Economic Growth in Selected Emerging Economies, *Global Disclosure of Economic and Business* 1 (1): 09-30

Awan, Abdul Ghafoor, Khan, Rana Ejaz Ali (2014). The Enigma of US Productivity Slowdown: A Theoretical Analysis, *American Journal of Trade and Policy* 1 (1): 7-15

Awan, Abdul Ghafoor (2015) Shifting Global Economic Paradigm, Asian *Business Review* 4 (3):35-40.

Awan, Abdul Ghafoor (2015) Comparative Analysis of the literature on Economic growth in the perspective of Advanced and Emerging Economies, *Science International* Lahore 27 (3): 2579-2587

Awan, Abdul Ghafoor (2012) Emerging versus Aging Economies: A Comparative study of Advanced and Emerging Economies. *International Journal of Management Research and Emerging Sciences* 2 (1): 45-65

Bakhsh, K., Rose, S., Ali, M. F., Ahmad, N., & Shahbaz, M. (2017). Economic growth, CO2 emissions, renewable waste and FDI relation in Pakistan: New evidence from 3SLS. *Journal of Environmental Management*, 196, 627–632. https://doi.org/10.1016/j.jenvman.2017.03.084

Benetrix, A., Pallan, H., & Panizza, U. (2023). *The elusive link between FDI and economic growth*. World Bank.

Cervellati, M., Meyerheim, G., & Sunde, U. (2023). The empirics of economic growth over time and across nations: A unified growth perspective. *Journal of Economic Growth*, 28, 173–224. https://doi.org/10.1007/s10887-022-09216-2

Costagliola, A. (2021). Labor participation and gender inequalities in India: Traditional gender norms in India and the decline in the labor force participation rate (LFPR). *Indian Journal of Labour Economics,* 64, 531–542. https://doi.org/10.1007/s41027-021-00329-7

Ekanayake, P. N. S. P., Madsen, J. B., & Bharati, T. (2023). Trade and economic growth: Does the sophistication of traded goods matter? *Journal of Economic Growth*, 28, 481–524. https://doi.org/10.1007/s10887-023-09224-w

Fisher, I. (1911a). *The purchasing power of money* (2nd ed.). Macmillan. (Reprinted in The Works of Irving Fisher, Vol. 4, 1997)

Hanif, I., Raza, S. M. F., Gago-de-Santos, P., & Abbas, Q. (2019). Fossil fuels, foreign direct investment, and economic growth have triggered CO2 emissions in emerging Asian economies: Some empirical evidence. *Energy,* 171, 493–501. https://doi.org/10.1016/j.energy.2018.12.112

Hasanov, F. J., Khan, Z., Hussain, M., & Tufail, M. (2021). Theoretical framework for the carbon emissions effects of technological progress and renewable energy consumption. *Sustainable Development,* 29(5), 810–823. https://doi.org/10.1002/sd.2175

Hussain, I., & Rehman, A. (2021). Exploring the dynamic interaction of CO2 emission on population growth, foreign investment, and renewable energy by employing ARDL bounds testing approach. *Environmental Science and Pollution Research,* 28, 1–11. https://doi.org/10.1007/s11356-021-15313-0

Jebli, M. B., Youssef, S. B., & Apergis, N. (2019). The dynamic linkage between renewable energy, tourism, CO2 emissions, economic growth, foreign direct investment, and trade. Latin *American Economic Review*, 28(1), 1–19. https://doi.org/10.1007/s40503-019-00081-9

Kahouli, B., & Maktouf, S. (2015). The determinants of FDI and the impact of the economic crisis on the implementation of RTAs: A static and dynamic gravity model. *International Business Review*, 24(3), 518–529. https://doi.org/10.1016/j.ibusrev.2014.10.012

Kashif, M., Lin, B., Shahbaz, M., & Shujaat, M. (2020). How energy consumption, industrial growth, urbanization, and CO2 emission affect

economic growth in Pakistan. *Energy*, 207, 118976. https://doi.org/10.1016/j.energy.2020.118976

Majumder, S. (2020). An empirical investigation of the FDI, export, and gross domestic saving on the economic growth in Bangladesh. *The Economics and Finance Letters*, 7(2), 255–267. https://doi.org/10.18488/journal.29.2020.72.255.267

Murshed, M. (2021). Modeling primary energy and electricity demands in Bangladesh: An autoregressive distributed lag approach. *Sustainable Production and Consumption*, 27, 698–712. https://doi.org/10.1016/j.spc.2021.06.014

Peng, L. (2015). Economic growth, foreign direct investment and CO2 emission in China. Punjab *Asian Development Policy Review*, 7(4), 307–317.

Qasim, Humaira; Awan, Abdul Ghafoor (2020) Impact of External Debt on Economic Growth of Pakistan. *Global Journal of Management, Social Sciences and Humanities* 6 *(*1): 30-61

Rehman, A., Ma, H., & Ozturk, I. (2020). Decoupling the climatic and carbon dioxide emission influence on maize crop production in Pakistan. *Air Quality, Atmosphere & Health,* 13, 1081–1093. https://doi.org/10.1007/s11869-019-00789-7

Rehman, A., Ma, H., Ozturk, I., Murshed, M., & Dagar, V. (2021). The dynamic impacts of CO2 emissions from different sources on Pakistan's economic progress: A roadmap to sustainable development. *Environment, Development and Sustainability,* 24, 1–24. https://doi.org/10.1007/s10668-021-01931-5.

Saeed, Fauzia; Awan, Abdul Ghafoor (20 20) Does Technological Advancement affect Economic growth? *Global Journal of Management, Social Sciences and* Humanities 6 (2).

Sadam, Z., Bokhari, S. A. H., Haider, Z., & Hussain, Z. (2019). The impact of inflation, CO2 emissions, and foreign direct investment on economic growth in Pakistan. Sustainability, 11(13), 3680. *https://doi.org/10.3390/su11133680*

Schumpeter, J. A. (1934). The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle (R. Opie, Trans.). Harvard University Press. (Original work published 1911)

Shahbaz, M., & Sinha, A. (2019). Environmental Kuznets curve for CO2 emissions: A literature survey. *Journal of Economic Studies*, 46(1), 106–168. https://doi.org/10.1108/JES-04-2018-0122

Tang, C. F., & Tan, B. W. (2015). The impact of energy consumption, income, and foreign direct investment on carbon dioxide emissions in Vietnam. *Energy,* 79, 447–454. https://doi.org/10.1016/j.energy.2014.12.061

Usman, Iftikhar; Awan, Abdul Ghafoor (2015). How does stock market development influence Economic Growth? *International Journal of Economics, Commerce and Management,* 3 (1): 1-19

Wang, L. (2019). Dynamic linkages among CO2 emissions, health expenditures, and economic growth: Empirical evidence from Pakistan. *Environmental Science and Pollution Research*, 26(26), 26914–26926. https://doi.org/10.1007/s11356-019-04876-x

World Bank. (2019). *World Development Indicators: Labor force participation rate. https://data.worldbank.org/indicator.