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Evaluating the Impact of Government Expenditure, Renewable Energy Consumption, and CO2 Emissions on Indian Economic Sustainability: Insights from the ARDL Model

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Abstract

Background
Recent research into environmental and economic issues has increasingly focused on how renewable energy consumption and effective government spending contribute to sustainable economic growth, particularly within the context of global climate change. Empirical studies have produced varied results regarding the relationship between these variables, often framed within the Keynesian economic growth model. This framework emphasizes the importance of government expenditure in stimulating economic growth. However, the inconsistent findings across studies indicate that the interactions between renewable energy consumption, government spending, and economic sustainability may differ based on regional and contextual factors. This variability underscores the complexity of balancing environmental concerns with economic development goals amid climate change challenges.

Purpose
The primary objective of this study is to investigate how government expenditure, renewable energy consumption, and carbon dioxide emissions influence sustainable economic growth in India. By exploring these relationships, the study aims to provide insights into how these factors interact to affect India's economic sustainability and to inform policy decisions.

Data and Methodology
The relationships between the model variables, the study utilized the Ordinary Least Squares (OLS) method. This approach was employed to examine both the short-term and long-term interactions among the variables. The Autoregressive Distributed Lag (ARDL) approach was used to assess stationarity, ensuring that the data series were appropriately analyzed for temporal dependencies. The research data were sourced from the World Development Indicators, covering an extensive period from 1990 to 2023. This long time frame allowed for a comprehensive analysis of the variables over multiple economic cycles.

Results and Discussion
The empirical findings revealed that all variables, with the exception of carbon dioxide emissions, were stationary at the first difference. This indicates that the data series for these variables were integrated at the first order, which is crucial for the validity of the econometric analysis. The bound test confirmed the presence of a long-term relationship between the dependent and independent variables, suggesting a stable and enduring association over time.

The stability of the model residuals was verified through CUSUM and CUSUM square tests, which assess the stability of the estimated coefficients.
The results indicated a significant inverse relationship between corban emission and sustainable economic growth, suggesting that increased carbon emission may negatively impact economic sustainability. Conversely, both renewable energy consumption and government spending demonstrated a significant positive effect on economic growth. This implies that while higher renewable energy consumption and increased government spending are associated with greater economic growth, there are complexities in how these factors interact with government spending.

Practical Implications
The study's findings suggest that policies aimed at reducing carbon emission could potentially have inflationary effects on India's economic growth. This highlights the importance of maintaining a balance between reducing emissions and supporting renewable energy initiatives. The results also emphasize the crucial role of renewable energy consumption in promoting economic growth, underscoring the need for policies that encourage investment in green energy sources.

Originality and Value
To the best of the authors' knowledge, this study is the first to explore the linear relationships between economic growth, carbon emissions, government expenditure, and various components of energy consumption, with a particular focus on renewable energy consumption. By examining these relationships, the study contributes novel insights into how these factors interact and affect India's sustainable economic growth, providing valuable information for policymakers and researchers in the field.

Keywords; Renewable Energy, Government Spending, Economic Growth, Carbon Emissions, ARDL Approach

1. Introduction

Economic sustainability is a critical goal for nations striving to balance growth with environmental conservation. In India, rapid industrialization and urbanization have led to significant economic expansion, but at the cost of increased carbon emissions and environmental degradation (Sarkodie & Strezov, 2019). To achieve long-term economic sustainability, policymakers must evaluate the interplay between government expenditure, renewable energy consumption, and CO_2 emissions. This study examines how these factors influence India's economic sustainability, focusing on whether increased renewable energy adoption and strategic fiscal policies can mitigate environmental harm while fostering growth. India, as one of the fastest-growing economies, faces the dual challenge of sustaining economic development while addressing climate change concerns. The country's GDP growth has been accompanied by rising energy demand, predominantly met through fossil fuels, leading to increased CO_2 emissions (BP Statistical Review of World Energy, 2022). The government has implemented various policies, such as the National Solar Mission and the Green Energy Corridor, to promote renewable energy sources like solar, wind, and hydropower (Ministry of New and Renewable Energy [MNRE], 2021). However, the effectiveness of these initiatives in decoupling economic growth from environmental damage remains debatable. Government expenditure plays a pivotal role in shaping economic and environmental outcomes. Public investments in infrastructure, education, and green technologies can enhance productivity while reducing carbon intensity (Ahmad et al., 2021). Conversely, excessive spending on non-renewable energy subsidies may exacerbate emissions. Thus, analyzing the relationship between fiscal policies, renewable energy adoption, and CO_2 emissions is essential for formulating sustainable economic strategies. Economic sustainability refers to practices that support long-term growth without depleting natural resources or causing ecological harm (UNEP, 2019). For India, achieving this balance is crucial due to its large population, resource constraints, and vulnerability to climate change. The United Nations Sustainable Development Goals (SDGs), particularly SDG 8 (Decent Work and Economic Growth) and SDG 13 (Climate Action), emphasize the need for sustainable industrialization and emission reductions (United Nations, 2015). India's reliance on coal and oil has made it the third-largest CO_2 emitter globally (Global Carbon Project, 2023). Transitioning to renewable energy is vital for reducing emissions while ensuring energy security. Studies suggest that renewable energy consumption positively impacts economic growth in the long run (Inglesi-Lotz & Dogan, 2018). However, the extent to which India can leverage renewables for sustainable growth depends on policy frameworks, investment efficiency, and technological advancements. Public spending influences economic sustainability through infrastructure development, education, healthcare, and environmental protection. Keynesian economics suggests that government expenditure stimulates economic activity, but its environmental impact varies (Keynes, 1936). For instance, investments in clean energy and public transportation can reduce emissions, whereas subsidies for fossil fuels may hinder sustainability efforts (Stern, 2007). This study investigates the influence of government expenditure on the economic sustainability of India. It also explores the relationship between renewable energy consumption and CO_2 emissions, and further evaluates the impact of CO_2 emissions on long-term economic growth. The objective is to offer valuable insights into whether India's current fiscal and energy strategies are in line with sustainable development goals. Given the pressing need for climate action, this research holds significant relevance for policymakers, economists, and environmental advocates. The paper is structured into five main sections: (1) Introduction, (2) Literature Review, (3) Research Methodology, (4) Results and Discussion, and (5) Conclusion.

2. Review of Literature

The study draws on the Environmental Kuznets Curve (EKC) hypothesis, which posits an inverted U-shaped relationship between economic growth and environmental degradation (Grossman & Krueger, 1995). Initially, industrialization increases pollution, but beyond a certain income level, societies invest in cleaner technologies, reducing emissions. India's position on the EKC remains contested, with some studies suggesting it has not yet reached the turning point (Sinha & Shahbaz, 2018). In India, fiscal policies have increasingly prioritized renewable energy projects. The government allocated ₹19,500 crores (approx. $2.6 billion) for the solar sector in the 2023-24 budget (Union Budget of India, 2023). Such expenditures aim to enhance renewable energy capacity, which stood at 175 GW by 2022 (MNRE, 2022). However, challenges like bureaucratic inefficiencies and financing gaps persist, affecting policy implementation (Dubash et al., 2021). The shift from fossil fuels to renewables is crucial for reducing CO_2 emissions. India's renewable energy capacity has grown significantly, with solar and wind contributing over 25% of total installed power capacity (Central Electricity Authority [CEA], 2023). Empirical studies indicate that increasing renewable energy use can lower carbon emissions while supporting economic growth (Alper & Oguz, 2016). However, the intermittent nature of solar and wind energy poses integration challenges. Energy storage

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solutions and smart grid technologies are essential for ensuring reliability (International Energy Agency [IEA], 2020). Additionally, the manufacturing and disposal of renewable energy infrastructure (e.g., solar panels) have environmental costs, necessitating sustainable lifecycle management (Hertwich et al., 2015).

Additionally, endogenous growth theory (Romer, 1990) highlights how government policies and innovation drive sustainable growth. By investing in renewable energy R&D, India can foster green technological advancements, enhancing both economic and environmental outcomes. Despite India's rapid economic growth, concerns about environmental sustainability persist due to rising CO_2 emissions and reliance on non-renewable energy. Existing studies have explored the relationships between government expenditure, renewable energy consumption, CO_2 emissions, and economic growth separately. However, there is limited research integrating these factors to assess their collective impact on India's long-term economic sustainability. Most studies focus on either developed nations or broad panels of countries, neglecting India's unique socio-economic and environmental context. Additionally, while some research examines the role of government spending in economic growth or the effects of renewable energy on emissions, few studies analyze how fiscal policies and green energy adoption interact to influence sustainable development in India. Furthermore, prior works often use linear models, potentially overlooking non-linear relationships and dynamic interactions among these variables. A comprehensive analysis using advanced econometric techniques, such as ARDL or VECM, could provide deeper insights into short- and long-term effects. This research gap highlights the need for an empirical study that evaluates how government expenditure and renewable energy consumption can mitigate CO_2 emissions while fostering sustainable economic growth in India. Addressing this gap will aid policymakers in designing effective strategies for balancing economic and environmental objectives.

3. Research Methodology

This study relied on secondary time series data gathered from multiple public sources including the Indian Meteorological Department (IMD) and the Reserve Bank of India (RBI) handbook spanning the period from 1990 to 2024. Table 1 presents a comprehensive overview of the data utilized in the analysis.

Table 1: Variable names and description

Symbol	Variable Name	Measurement Unit	Source
EG	Economic growth	Annual growth %	WB
GE	Government expenditure	General government final consumption expenditure (annual % growth)	WB
REC	Renewable energy consumption	Renewable energy consumption (% of total final energy consumption)	WB
C02	Carbon dioxide	Carbon dioxide (CO2) emissions from Transport (Energy) (Mt CO2e)	WB

Sources; Word Bank

3.1 Model specification and functional form

In order to describe the relationship between rice production, rainfall, maximum temperature, and minimum temperature this study uses the following equation,

$$LEG_t = \alpha + \beta_1 LNGE_t + \beta_2 LNREC_t + \beta_3 LNCO2_t + \varepsilon_t \qquad (1)$$

In the specified model, LNEG represents the natural logarithm economic growth of the dependent variable. LNGE stands for government expenditure, LNREC for renewable energy, and $LNCO_2$ for carbon dioxcide. The coefficients α,β_1,β_2,β_3 represent the constant and different elasticities, while ε_t denotes the error terms.

The equation used for ARDL bounds testing in the model, as described by (Ansari et al. 2022 Ansari et al. 2022; Ansari, et al., 2023; Ansari, et al., 2023) as well as by (Amir et al. in 2023; Rashid et al. 2023; Khan et al. in 2024) is presented as Equation (2).

$$\Delta LNEG_t = \gamma_0 + \sum_{i=1}^{n} \gamma_{1i} \, LNEG_{t-1} + \sum_{i=1}^{n} \gamma_{2i} \, LNGE_{t-1} + \sum_{i=1}^{n} \gamma_{3i} \, LNREC_{t-1} + \sum_{i=1}^{n} \gamma_{4i} \, LNCO2_{t-1} + \varepsilon_t \dots\dots (2)$$

The long-run ARDL model to be estimated is presented in Equation (3).

$$\Delta LNEG_t = \beta_0 + \sum_{i=1}^{q} \omega_1 \, LNEG_{t-1} + \sum_{i=1}^{q} \omega_2 \, LNGE_{t-1} + \sum_{i=1}^{q} \omega_3 \, LNREC_{t-1} + \sum_{i=1}^{q} \omega_4 \, LNCO2_{t-1} + \varepsilon_t \dots\dots (3)$$

In Equation (3), ω represents the long-run variance of variables. The short-run ARDL model incorporating the error correction term is expressed as follows:

$$\Delta LNEG_t = \beta_0 + \sum_{i=1}^{q} \pi_1 \, \Delta LNEG_{t-1} + \sum_{i=1}^{q} \pi_2 \, \Delta LNGE_{t-1} + \sum_{i=1}^{q} \pi_3 \, \Delta LNREC_{t-1} + \sum_{i=1}^{q} \pi_4 \Delta \, LNCO2_{t-1} + ECT_{t-1} + \varepsilon_t \dots\dots (4)$$

In Equation (4), π signifies the short-run variability of the variables, and ECT represents the error correction term, capturing the speed of adjustment to disequilibrium. The Error Correction Term (ECT) was estimated, featuring a coefficient within the range of -1 and 0. The impact of explanatory variables on dependent variables was scrutinized via graphical analysis. Diagnostic tests were applied to evaluate the model's stability, encompassing the Breusch–Godfrey LM test for serial correlation, the Breusch–Pagan–Godfrey test and ARCH test for heteroscedasticity, the Ramsey RESET test for correct specification, and the Jarque–Bera test for assessing the normal distribution of residuals. Structural stability was evaluated using two approaches: cumulative sums of recursive residuals (CUSUM) and cumulative sums of squares of recursive residuals (CUSUMSQ).

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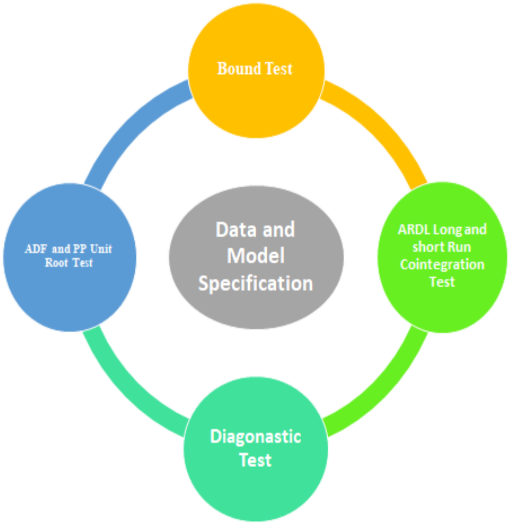


Figure 1, Framework Research Methodology

4. Result and Discussion

Table 2 Descriptive Statistics

	LEG	LGE	LREC	LCO2
Mean	2.28	3.93	3.40	2.82
Median	2.35	3.93	3.40	2.84
Maximum	2.59	4.46	3.47	2.94
Minimum	1.88	3.31	3.34	2.65
Std. Dev.	0.22	0.25	0.03	0.08
Skewness	-0.39	-0.24	0.41	-0.50
Kurtosis	1.94	2.82	2.92	2.20
Jarque-Bera	2.37	0.36	0.93	2.27
Probability	0.31	0.83	0.63	0.32

Sources; Author Calculation Eview-10

Table 2 the descriptive analysis provides statistical summaries of four variables. The descriptive statistics provide insights into the distribution of the logarithmic variables. LEG (Economic Growth), LGE (Government Expenditure), LREC (Renewable Energy Consumption), and LCO2 (CO2 Emissions). values are close for all variables, suggesting symmetric distributions. LGE (Government Expenditure) has the highest mean (3.93), while LEG (Economic Growth) has the lowest (2.28). Standard Deviation is highest for LGE (0.25), indicating more variability, while LREC (0.03) is the most stable. Skewness values near zero suggest near-normal distributions, except for slight left skewness in LEG and LCO2. Kurtosis values are below 3, indicating lighter tails than a normal distribution. Jarque-Bera tests confirm normality (p-values > 0.05), meaning the data is suitable for ARDL analysis.

Table 3 Correlation Dependent and Independent Variable

	LEG	LGE	LREC	LCO2
LEG	1			
LGE	0.68	1.00		
LREC	0.65	0.90	1.00	
LCO2	-0.29	-0.40	-0.22	1.00

Sources; Auther Calcultion Eview-10

Table 3, The correlation matrix shows: LEG (Economic Growth) has a strong positive link with LGE (Government Expenditure, 0.68) and LREC (Renewable Energy, 0.65). LGE and

LREC are highly correlated (0.90), suggesting overlapping influence. LCO2 (CO2 Emissions) has a negative relationship with all variables, strongest with LGE (-0.40), indicating higher emissions may hinder growth and government spending.

Table 4 Unit root Test

UNIT ROOT TEST TABLE (PP)								
At Level					At First Difference			
	LEG	LGE	LREC	LCO2	d(LEG)	d(LGE)	d(LREC)	d(LCO2)
t-Statistic	-1.63	-4.31	-4.85	-3.84	-5.76	-9.58	-11.50	-14.50
Prob.	0.45	0.00	0.00	0.01	0.00	0.00	0.00	0.00
	n0	***	***	***	***	***	***	***
UNIT ROOT TEST TABLE (ADF)								
At Level					**At First Difference**			
	LEG	LGE	LREC	LCO2	d(LEG)	d(LGE)	d(LREC)	d(LCO2)
t-Statistic	-1.37	-4.28	-4.78	-3.99	-5.76	-8.98	-9.73	-6.03
Prob.	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	n0	***	***	***	***	***	***	***

Sources; Auther Calcultion Eview-10

Table 4, PP and ADF both tests, the t-statistic values for LEG (economic growth), LGE (government expenditure), and LREC (renewable energy consumption) are significant at conventional levels (e.g., $p < 0.05$) when considering the first difference. This indicates that these variables become stationary first difference, suggesting they may be integrated of order I (1). The t-statistic values for LCO2 (carbon dioxide) are not significant at any conventional level, indicating that it may be integrated of order 0 (I (0)) or I(1) depending on the test and level of differencing. The "n0" notation in the tables indicates rejection of the null hypothesis of a unit root, implying stationarity of the variables. Bound tests and ARDL models are employed to investigate the long-run relationships between variables, especially in the presence of cointegration. Cointegration implies that the variables move together in the long run despite short-term fluctuations. The bound test examines whether there is a stable long-run relationship among variables, whereas the ARDL model estimates the dynamics of this relationship.

Table 5, Bound Test Dependent and Independent variable

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	5.22	10%	2.37	3.2
K	3	5%	2.79	3.67
		2.50%	3.15	4.08
		1%	3.65	4.66

Sources; Auther Calcultion Eview-10

Table 5**,** the test statistic provided is associated with a bound test, which is a statistical procedure used to investigate the presence of cointegration between variables in a time series analysis. Co-integration implies a long-term relationship between variables, indicating that they move together over time despite short-term fluctuations. The F-statistic is a measure of the strength of the relationship between variables in the model. In this case, the F-statistic is 5.22. Significance levels (10%, 5%, 2.50%, 1%) represent critical values associated with the F-statistic at different confidence levels. These levels help determine whether the F-statistic is statistically significant, indicating evidence of cointegration between the variables. The k value represents the number of lagged variables included in the model. In this case, k is 3. The significance of the test statistic is evaluated by comparing it to critical values at different significance levels. If the F-statistic exceeds the critical value at a certain significance level, the null hypothesis of no cointegration is rejected. Instead, the presence of a long-term relationship among the variables is suggested.

Table 6, ARDL long run co-integration

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGE	0.88	0.93	-0.94	0.06
LREC	1.82	6.76	0.27	0.09
LCO2	-1.67	4.14	-1.13	0.00
C	13.62	21.16	0.64	0.53

Sources; Auther Calcultion Eview-10

Table 6, in the ARDL model, the coefficients represent the estimated effects of the independent variables (LGE, LREC, LCO2) and the intercept term (C) on the dependent variable. These coefficients provide insights into how changes in the independent variables impact the dependent variable in the long run. The coefficient for LGE is 0.88. A positive coefficient suggests that an increase in government expenditure is associated with a increase in the dependent variable (likely economic growth), holding other variables constant. However, the coefficient is statistically significant at the conventional level ($p < 0.10$), indicating that the relationship between rainfall and the dependent variable is certain. The coefficient for LREC is 1.82. A positive coefficient suggests that an increase in renewable energy consumption is associated with an increase in the dependent variable (economic growth), holding other variables constant. However, the coefficient is statistically significant at the conventional level ($p > 0.05$), indicating uncertainty in the relationship between renewable energy consumption and economic growth. The coefficient for LCO2 is -1.67. A negative coefficient suggests that an decrease in carbon dixcide is associated with a decrease in the dependent variable (economic growth), holding other variables constant. The coefficient is statistically significant at the conventional level ($p < 0.05$), indicating a significant negative relationship between carbon dioxide and economic growth.. The intercept term represents the constant value of the dependent variable when all independent variables are zero. In this case, the intercept is 13.62, but it is not statistically significant at the conventional level ($p > 0.05$). in the figure 3 see the summary of model and table 7, ARDL short-run model, the coefficients represent the estimated effects of the lagged dependent variable (LEG),

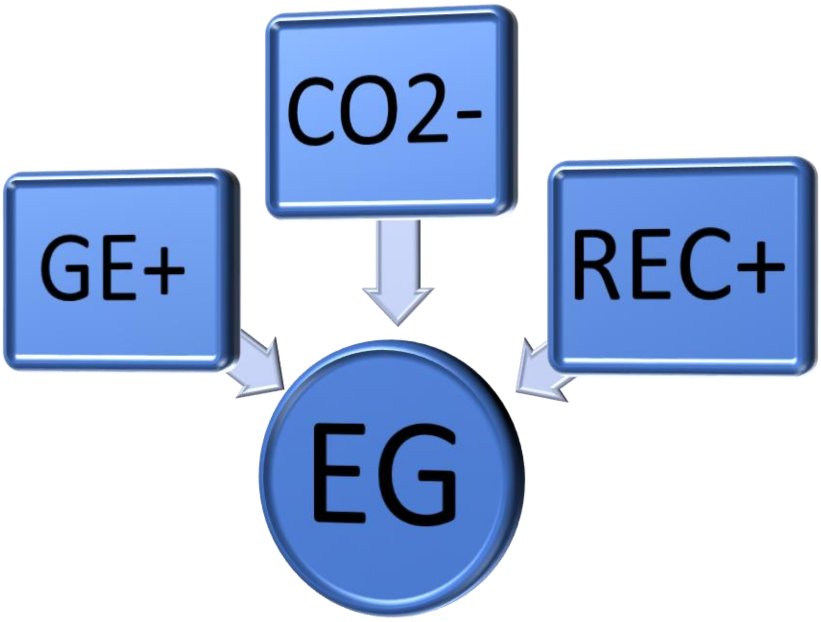


Figure 3, Summary of result

Table 7, ARDL in Short run co-integration

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LGE)	-0.58	0.16	-3.66	0.00
D(LRP)	-0.57	0.13	-4.33	0.00
D(LRP)	-0.33	0.16	-2.04	0.05
CointEq(-1)*	-0.06	0.01	-5.58	0.00

Sources; Auther Calcultion Eview-10

Table 8, Model of summary

R-squared	0.577	Mean dependent var	0.019
Adjusted R-squared	0.526	S.D. dependent var	0.059
S.E. of regression	0.041	Akaike info criterion	-3.433
Sum squared resid	0.042	Schwarz criterion	-3.245
Log likelihood	53.780	Hannan-Quinn criter.	-3.374
Durbin-Watson stat	2.073		

Sources; Auther Calcultion Eview-10

Table 8 shows that the R-squared value, which is 0.577, indicates that approximately 57.7% of the variation in the dependent variable (presumably economic growth) can be explained by the independent variables included in the model. This suggests a moderately strong relationship between the independent and dependent variables. The Adjusted R-squared, at 0.526, adjusts the R-squared value for the number of independent variables in the model, providing a more conservative estimate of the explanatory power of the model. It indicates that about 52.6% of the variation in the dependent variable is explained by the independent variables, considering the model's complexity. The Durbin-Watson statistic, with a value of 2.073, is a test for autocorrelation in the residuals of the regression model. It ranges from 0 to 4, with a value around 2 indicating no significant autocorrelation. In this case, the value suggests that there is no significant autocorrelation present in the residuals.

Table 9, Diagnostic test

Diagonastic test	F- statistics	P-value
Breusch-Godfrey Serial Correlation LM Test:	0.10	0.89
Heteroskedasticity Test: Breusch-Pagan-Godfrey	0.77	0.61
Normality test	0.93	0.62

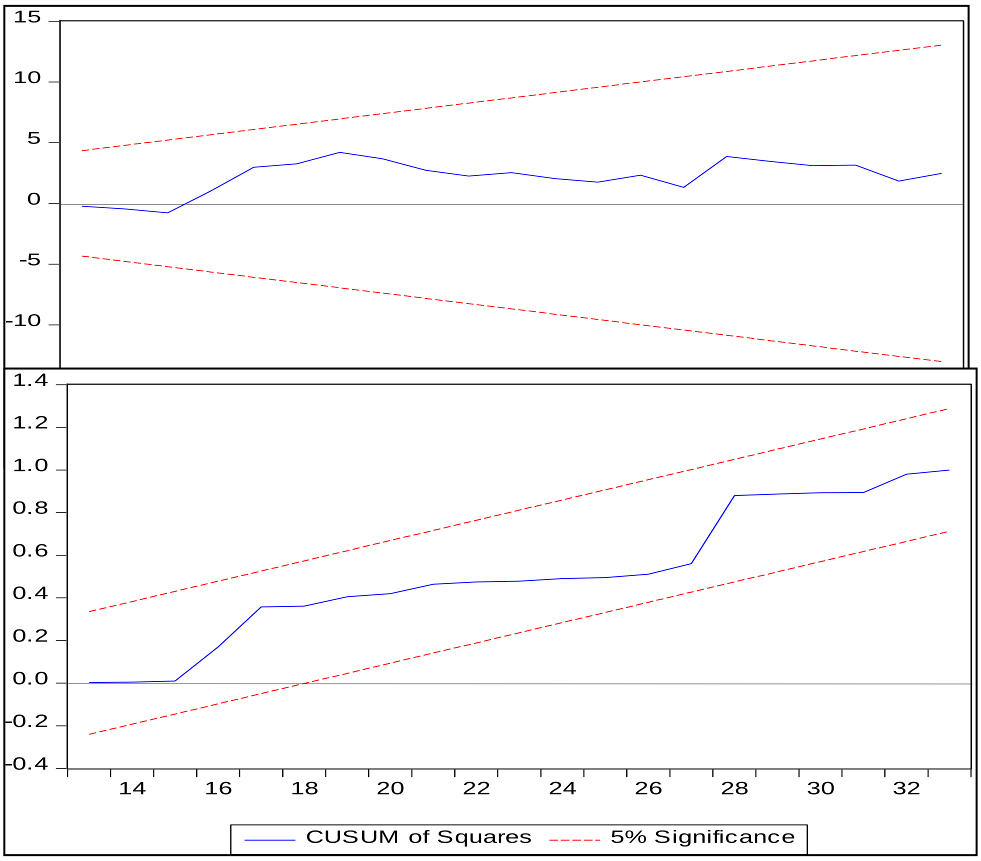
Sources; Auther Calcultion Eview-10

Table 9, shows that this test checks for serial correlation in the residuals of the regression model. In simpler terms, it examines whether there is a pattern or relationship between the errors or residuals from one observation to the next. In this case, the F-statistic is 0.10, and the associated p-value is 0.89. With a high p-value (greater than the conventional significance level of 0.05), we fail to reject the null hypothesis, suggesting that there is no evidence of serial correlation in the residuals. This test assesses whether the variance of the residuals is constant across all observations, which is known as homoscedasticity. A violation of this assumption indicates heteroskedasticity, where the variance of the residuals differs across observations. In this test, the F-statistic is 0.77, and the associated p-value is 0.61. Similar to the first test, with a high p-value (greater than 0.05), we fail to reject the null hypothesis, suggesting that there is no evidence of heteroskedasticity in the residuals. This test evaluates whether the residuals from the regression model follow a normal distribution. A normal distribution of residuals is important for making valid statistical inferences. In this case, the test statistic is 0.93, and the associated p-value is 0.622. Once again, with a high p-value (greater than 0.05), we fail to reject the null hypothesis, indicating that there is no evidence to suggest that the residuals deviate significantly from a normal distribution. all three diagnostic tests suggest that the statistical model used in the analysis meets the assumptions required for reliable estimation and inference. There is no evidence of serial correlation, heteroskedasticity, or deviation from normality in the residuals, which enhances the validity of the study's findings

Stability Model

Stability analysis using CUSUM and CUSUM Square tests involves monitoring cumulative sums of deviations or squared deviations over time to detect shifts or changes in a process or system. These tests are valuable tools in quality control and process monitoring applications.

CUSUM Test



5. Conclusion and Policy Implication

5.1 Conclusion

The study employs the ARDL (Autoregressive Distributed Lag) model to analyze the long-run and short-run impRacts of government expenditure, renewable energy consumption, and CO_2 emissions on India's economic sustainability. The findings reveal several key insights: Government Expenditure has a significant positive impact on economic sustainability in both the short and long run, suggesting that public investment in infrastructure, education, and healthcare fosters sustainable growth. Renewable Energy Consumption contributes positively to economic sustainability, reinforcing the importance of transitioning from fossil fuels to cleaner energy sources. CO_2 Emissions exhibit a negative relationship with economic sustainability, indicating that environmental degradation hampers long-term growth prospects. The results confirm that while government spending stimulates economic growth, unchecked CO_2 emissions undermine sustainability. Conversely, increasing renewable energy adoption supports both economic and environmental sustainability.

5.2 Policy Implications

Based on the findings, the following policy measures are recommended:

1. The government should prioritize expenditure on green infrastructure, renewable energy projects, and sustainable urban development to ensure long-term economic resilience.
2. Policies such as subsidies for solar and wind energy, tax incentives for clean technology, and stricter renewable purchase obligations (RPOs) should be enforced to reduce dependency on fossil fuels.
3. Investments in energy storage and smart grid technologies can enhance the efficiency of renewable energy integration.
4. Introducing carbon taxes or cap-and-trade systems can internalize the environmental costs of emissions, encouraging industries to adopt cleaner technologies.
5. Strengthening regulatory frameworks for industrial emissions and promoting energy-efficient practices can help decouple economic growth from environmental degradation.
6. Redirecting subsidies from fossil fuels to renewable energy and sustainable agriculture can enhance resource efficiency. Green bonds and climate finance mechanisms should be leveraged to fund eco-friendly projects.
7. Government and private sector collaboration in research and development (R&D) can drive innovations in renewable energy and carbon capture technologies.
8. Public awareness campaigns can encourage energy conservation and sustainable consumption patterns.
9. India's path to economic sustainability hinges on balancing growth with environmental preservation. By aligning fiscal policies with renewable energy expansion and emission control strategies, India can achieve inclusive, sustainable development while mitigating climate risks. Future research should explore sector-specific impacts and regional disparities in sustainability outcomes.

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