

# IMPACT OF PETROLEUM EXPORTS ON ECONOMIC GROWTH IN INDIA: AN ARDL APPROACH

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## ABSTRACT

The main aim of this study is to provide systematic analysis of impact of petroleum exports on economic growth in India using Auto Regressive Distribute Lag (ARDL) model. The Augmented Dickey-Fuller test results revealed that the time series data for both the dependent and independent variables display stationary characteristics at mixed levels. Bounds test concluded that a long-term relationship exists between the independent variables and the dependent variable. The ARDL long-run estimation results indicated a positive relationship between petroleum exports and economic growth in India. The coefficients associated with petroleum exports were found to be statistically significant at the one per cent level. The coefficient of the error correction term in short-run, as indicated, holds substantial significance and exhibits a negative sign. This finding confirms the existence of a cointegration relationship between the variables. Specifically, approximately 1.3 per cent of disequilibrium from the shock experienced in the previous year converges back to the long-run equilibrium in the current year, with a statistical significance of one per cent. Consequently, the outcomes suggest that petroleum exports exert both short-run and long-run impacts on the economic growth of India. As a result, the study advises the government (policy makers) to focus on reducing the total costs, improving more refinery companies, and enhancing the competitiveness of India's petroleum exports.

**Keywords:** Petroleum Exports, Economic Growth, India, ARDL, ADF.

## 1. INTRODUCTION

India's economy has undergone a significant transformation, transitioning from a mixed planned economy to a mixed middle-income developing social market economy. Notably, there is a substantial presence of the public sector in strategic sectors. In terms of nominal GDP, India ranks as the world's fifth-largest economy, and it holds the third-largest position based on purchasing power parity. However, when considering per capita income, India's GDP ranks 139<sup>th</sup>, and its GDP ranks 127<sup>th</sup>. From the time of independence in 1947 until 1991, successive governments in India followed the Soviet model and implemented protectionist economic policies. These policies included extensive Sovietization, state intervention, demand-side economics, reliance on natural resources, bureaucrat-driven enterprises, and economic regulation. This approach, known as dirigism, was characterized by the License Raj. However, the end of the Cold War and a severe balance of payments crisis in 1991 prompted India to adopt a broad economic liberalization policy and indicative planning. Since the beginning of the 21<sup>st</sup> century, India has experienced an average annual GDP growth rate of 6 per cent to 7 per cent. It is worth noting that prior to the onset of colonialism in the early 19<sup>th</sup> century; the economy of the Indian subcontinent was the largest in the world for most of recorded history. In terms of trade, India was the sixth-largest importer and the ninth-largest exporter in 2022. Since joining the World Trade Organization on January 1, 1995, India has actively participated in global trade. However, it ranks 63<sup>rd</sup> on the Ease of Doing Business Index and 40<sup>th</sup> on the Global Competitiveness Index, indicating room for improvement in terms of business environment and competitiveness.

### 1.1 History and Evaluation

The Indian Petroleum refining sector has made significant progress since the discovery of crude oil and the establishment of the first refinery in Digboi in 1901. Prior to 1947, this was the only refinery with a capacity of 0.50 million metric tonnes per annum (MMTPA). The Mumbai Refinery of HPCL, which was set up by Esso in 1954, became the first modern refinery after India gained independence. This was followed by the establishment of refineries by other major oil companies such as Burmah Shell and Caltex in Mumbai (BPCL) and Visakhapatnam (HPCL). Over the years, refineries have been established by the Government, Private Sector, and through Joint Ventures. India has experienced remarkable growth in the refining sector, transitioning from a deficit scenario in 2001 to achieving self-sufficiency in refining. Today, India is a significant exporter of high-quality petroleum products and has become a global refining hub. With a refining capacity of 248.9 MMTPA, India is the fourth-largest refining country in the world, after the United States, China, and Russia. The country has a total of 23 refineries, with 18 in the Public Sector, 2 in Joint Ventures, and 3 in the Private Sector. These refineries are strategically located across the country and are connected through cross-country pipelines.

## 2. REVIEW OF LITERATURE

**Sajal Ghosh (2009)** in his study examined the relationship between the quantities of crude oil import, income, and price of imported crude in India from 1970–1971 to 2005–2006. The autoregressive distributed lag bounds testing approach of cointegration is used to establish a long-run equilibrium relationship. The empirical results indicated that the long-term income elasticity of imported crude in India was 1.97. Furthermore, there was a unidirectional long-run causality from economic growth to crude oil import. The study concluded that reducing crude oil import will not have a significant impact on future economic growth in India in the long run. To decrease import dependence, India should implement various energy efficiency and demand side management measures in the transport sector. Additionally, expanding and strengthening the indigenous resource-base, substituting imported fuels with domestic fuels, and de-controlling the price of petroleum products are recommended measures.

**Seema Narayan, Thai-Ha Le, Badri Narayan Rath and Nadia Doytch (2014)** in their research paper pointed that between 1985 and 2013, the wealthier states in India experienced a prevalence of the feedback hypothesis in relation to the relationship between real gross domestic product growth and petroleum consumption. In the short term, all 23 major Indian state panels provide evidence supporting the conservative hypothesis. However, when considering the panels consisting of low and middle-income Indian states, although there were significant bidirectional effects in the long term, none of the findings suggest that increased energy consumption leads to economic growth. This implies that it is possible to control the growth in energy demand without negatively impacting economic growth. Nevertheless, the results indicate that for the low- and middle-income states, an increase in petroleum consumption could have adverse effects on economic activity in both the short and long term. These findings are based on aggregate data on petroleum. When examining the linkages between energy and growth in the short and long term using disaggregated data on petroleum consumption, it is revealed that only a few specific types of petroleum products have stable long-term relationships with economic growth. In fact, when analyzing disaggregated petroleum data, the vector error correction model and cointegration results support the neutral hypothesis for high-income states. On the other hand, for the low- and middle-income groups, while the conservation effect is observed in both the short and long term, higher economic growth seems to lead to a decrease in the consumption of selected types of petroleum products.

**Saeid Satari Yuzbashkandi & Mehrdad Aghaei Sadi (2020)** have analyzed the correlation between economic growth, measured by gross domestic production, and petroleum production for the Organization of Petroleum Exporting Countries from 2000 to 2016. To assess the existence of this relationship, panel co-integration tests were conducted. Additionally, the dynamic OLS and fully modified OLS panel co-integration methods were utilized to investigate the long-term impact of PP on GDP growth. Furthermore, the pool mean group method was employed to estimate the short-term coefficient and causality relationship. The results indicated that both GDP and PP are non-stationary and co-integrated series. The calculated panel coefficients using FMOLS, DOLS, and PMG were 0.64, 0.76, and 0.86, respectively. Moreover, there was a one-way causality from PP to GDP.

## 3. METHODOLOGY

The investigation solely relies on secondary data. The necessary data have been obtained from the Ministry of Petroleum and Natural Gas, Government of India, and Handbook of Statistics of Indian Economy. The study period for the investigation spanned 33 years from 1990-91 to 2022-23. The data have been thoroughly analyzed using econometric tools such as the auto regressive distributed lag model (ARDL), unit root test, bounds test, residual diagnostics test, and stability diagnostics test. The investigation has been conducted using E-views 10.

#### 4. RESULTS AND DISCUSSIONS

**Table 1:** Descriptive Statistics

Variable	Economic Growth	Petroleum Exports
Mean	7633943.0	124865.2
Median	3953276.0	81094.00
Maximum	27240712	458688.0
Minimum	531813.0	309.0000
Standard Deviation	7726190.0	135411.7
Skewness	1.011336	0.731212
Kurtosis	2.803322	2.354738
Jarque-Bera	5.678589	3.513193
Probability	0.58467	0.172631

**Source:** Authors' compilation.

Before proceeding with the estimation of the auto regressive distributed lag cointegration, it was necessary to complete several preparation steps. The initial step involved visually and statistically analyzing the data. Descriptive statistics for the variables are presented in Table 1. Over the period from 1990-91 to 2022-23, the average economic growth in India was approximately 7,633,943.0, with a maximum economic growth of 27,240,712 and a minimum economic growth of 531,813.0. Similarly, the average export of petroleum in India was around 124,865.2, with maximum petroleum exports of 458,688.0 and a minimum of 309.0. The standard deviation of both economic growth and petroleum exports suggests that the data points are concentrated around the mean, and both variables exhibit positive skewness. However, the kurtosis values for these variables do not exceed 2.0, indicating that they do not exhibit excessive peakedness or flatness. Furthermore, based on the Jarque-Bera test, both variables can be considered normally distributed.

#### 5. UNIT ROOT TEST

The present study employed the Augmented Dickey-Fuller unit root test to examine the presence of a unit root in each of the time series variables. To decide the request for incorporation, analysis started with the Augmented Dickey-Fuller (ADF) unit root tests and the results are furnished in Table 1.

**Table 1:** Unit Root Test (Augmented Dickey-Fuller Test)

Variable	Intercept (Schwarz Info Criterion)							
	Level				1 <sup>st</sup> Difference			
	t-Stat	1% TCV	5% TCV	10% TCV	t-Stat	1% TCV	5% TCV	10% TCV
GDP	6.620	-3.653	-2.957	-2.617	-0.260	-3.679	-2.967	-2.622
PEX	0.147	-3.857	-3.040	-2.660	-2.915	-3.711	-2.981	-2.629
Variable	Trend and Intercept (Schwarz Info Criterion)							
	Level				1 <sup>st</sup> Difference			
	t-Stat	1% TCV	5%	10%	t-Stat	1% TCV	5% TCV	10%

			TCV	TCV				TCV
GDP	1.755	-4.296	-3.568	-3.218	-5.009	-4.416	-3.622	-3.248
PEX	-3.779	-4.339	-3.587	-3.229	-4.490	-4.416	-3.622	-3.248

Source: Authors' compilation.

The findings from the Augmented Dickey-Fuller test indicated that both variables (Intercept) were non-stationary at the level, whereas petroleum exports (Intercept & Trend and Intercept) were stationary at the level with a significance level of 5 per cent. The Augmented Dickey-Fuller test results revealed that the variables exhibit a combination of stationary levels, namely I (0) and I (1). Specifically, petroleum exports are stationary at I (0), while Economic growth is stationary at I (1). Consequently, it can be inferred that the time series data for both the dependent and independent variables display stationary characteristics at mixed levels. Given these observations, the author opted for the autoregressive distributed lag approach to co-integration method in this study, as it is deemed the most appropriate technique for analyzing this type of dataset.

## 6. F-BOUNDS TEST

After conducting the Augmented Dickey-Fuller tests to assess the level of integration for both variables, the analysis proceeded to employ the F-Bounds test, as presented in Table 2.

Table 2: F-Bounds Test

Null Hypothesis: No Long run relationships exist				
Test Statistic	Value	Significance Level	Lower Bound I(0)	Upper Bound I(1)
F-statistic	89.036	10%	3.02	3.51
		5%	3.62	4.16
		2.5%	4.18	4.79
		1%	4.94	5.58

Source: Authors' compilation.

The results indicated that when considering economic growth as the dependent variable and petroleum exports of India as the independent variables, the null hypothesis suggests the absence of a long-term relationship, while the alternative hypothesis suggests the presence of a cointegrating relationship. It is important to highlight that the F-statistic value is 89.036, surpassing all the upper bounds at significance levels of 1 per cent, 2.5 per cent, 5 per cent, and 10 per cent. Consequently, the null hypothesis was rejected, and the alternative hypothesis was accepted. Thus, it can be concluded that a long-term relationship exists between the independent variables and the dependent variable.

## 7. ARDL LONG RUN TEST

After bound test's results confirmed that there is long run co-integration relationship between dependent variable and independent variable of (1,3). The following table showed the results for auto regressive distributed lag long run test.

Table 3: Long Run Coefficient of ARDL Test with Lag (1, 3)

Variable	Coefficient	Std. Error	t-Statistic	Probability
C	97297.64	87901.50	1.106894	0.2793
GDP(-1)	0.013017	0.019526	0.666626	0.5114

PET(-1)	4.865734	1.127515	4.315450	0.0002
D(PET)	10.22670	1.214867	8.417956	0.0000
D(PET(-1))	-2.895411	1.337868	-2.164199	0.0406
D(PET(-2))	-5.223691	1.833717	-2.848690	0.0089

**Source: Authors' compilation.**

The findings from the long-run estimation using the auto regressive distributed lag (1, 3) model are displayed in Table 3. In this particular study, the selection of the auto-regressive distributed lag model was guided by the AIC criterion. The results indicated a positive relationship between petroleum exports and economic growth in India. The coefficients associated with petroleum exports were found to be statistically significant at the one per cent level. According to the findings from the extensive analysis, it has been verified that the long-run progress of India's economy is heavily dependent on the exportation of petroleum. In order to bolster this sector, the government ought to focus on refining trade policies, liberalizing the industry, and fostering the export of high-quality petroleum to international markets. Additionally, to ensure economic stability, it is imperative for the government to implement efficient monetary policies.

## 8. SHORT RUN TEST

**Table 4:** Short Run Error Correction of ARDL Test

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PEX	10.226	1.101	9.283	0.000
CointEq (-1)*	0.013	0.001	17.010	0.000
R <sup>2</sup>	0.911148	Mean Dependent Var		884566.3
Adjusted R <sup>2</sup>	0.900896	S.D. Dependent Var		959172.7
S.E. of Regression	301955.7	AIC		28.19751
Sum Square Residual	2.37E+12	SIC		28.38434
Log Likelihood	-418.9627	HIC		28.25728
Durbin-Watson Stat	1.893227			

**Source: Authors' compilation.**

Table 4 presents the application of the error correction model to examine the immediate effects of petroleum exports on the economic growth of India. The coefficient of the error correction term, as indicated in table 4, holds substantial significance and exhibits a negative sign. This finding confirms the existence of a cointegration relationship between the variables. Specifically, approximately 1.3 per cent of disequilibrium from the shock experienced in the previous year converges back to the long-run equilibrium in the current year, with a statistical significance of one per cent. Consequently, the outcomes suggest that petroleum exports exert both short-run and long-run impacts on the economic growth of India.

## 9. RESIDUAL DIAGNOSTICS TEST

The present research study employed the residual diagnostics test to assess the normality, Breusch-Godfrey serial correlation LM, and heteroskedasticity of the model. Additionally, the normality test was utilized to examine the distribution's normality. The Breusch-Godfrey Serial Correlation LM test was employed to investigate the presence of serial correlation within the residual diagnostics of the model. Furthermore, the heteroskedasticity test was conducted to identify any heteroskedastic problems within the model. The results of these tests are displayed in Table 5.

**Table 5:** Residual Diagnostics Test

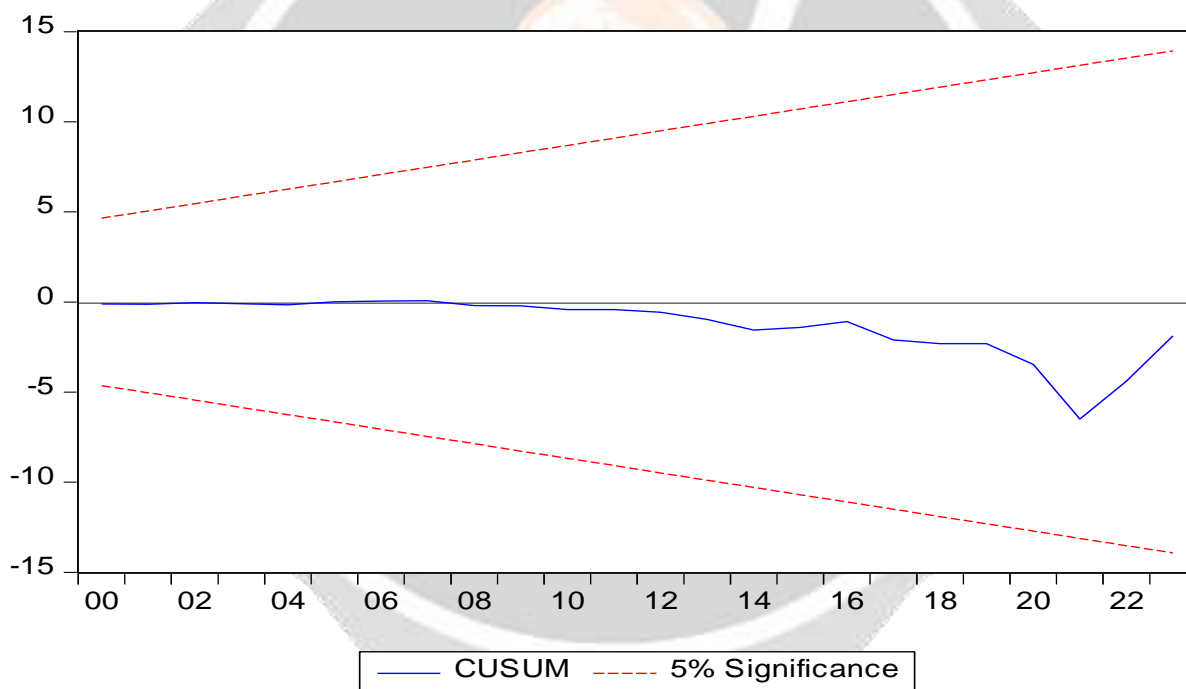
Model	Test Statistic	Probability
Normality Test	2.894	0.235
Breusch-Godfrey Serial Correlation LM Test	28.246	0.000
Heteroskedasticity Test	9.463	0.000

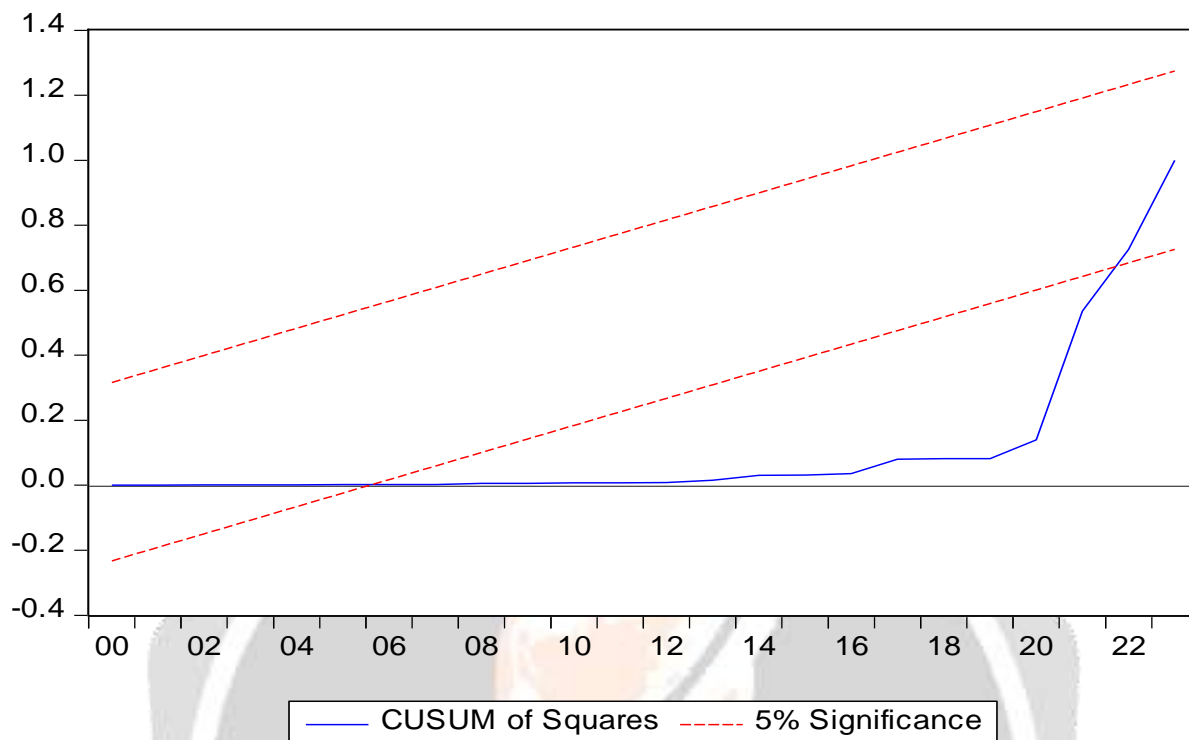
Source: Authors' compilation.

Residual diagnostics tests require the probability value of Serial Correlation and Heteroskedasticity tests to be at the one per cent level. However, the results of the Normality test indicate an insignificant level. According to Table-5, the Serial Correlation test for the null hypothesis reveals the presence of serial correlation. The probability value for this test is 0.000, indicating a significant level of one percent. Therefore, the null hypothesis is rejected, suggesting the existence of serial correlation among the variables. Similarly, the null hypothesis for heteroskedasticity assumes the presence of heteroskedasticity problem. The probability value for heteroskedasticity is also 0.000, indicating a significant level of one percent. Consequently, the null hypothesis is rejected, indicating the presence of heteroskedasticity problems.

### 10. STABILITY DIAGNOSTICS TEST

Figure 1: CUSUM Test



**Figure 2: CUSUM of Squares Test**

The stability of the economic growth equation was examined in this research paper through the utilization of two tests: the cumulative sum of residual test and the cumulative sum of squares of recursive residuals test. The outcomes of these tests, as depicted in Figure 1 and Figure 2, were found to fall within the critical bounds. The representation of the results as a pair of straight lines indicated that the model remains stable throughout the same period.

## 11. CONCLUSIONS

The main aim of this study is to provide systematic analysis of impact of petroleum exports on the economic growth of India using ARDL model. The Augmented Dickey-Fuller test results revealed that the variables exhibit a combination of stationary levels, namely I (0) and I (1). Specifically, petroleum exports were stationary at I (0), while Economic growth was stationary at I (1). Consequently, it can be inferred that the time series data for both the dependent and independent variables display stationary characteristics at mixed levels. Bounds test concluded that a long-term relationship exists between the independent variables and the dependent variable. The ARDL long-run estimation results indicated a positive relationship between petroleum exports and economic growth in India. The coefficients associated with petroleum exports were found to be statistically significant at the one per cent level.

The coefficient of the error correction term, as indicated, holds substantial significance and exhibits a negative sign. This finding confirms the existence of a cointegration relationship between the variables. Specifically, approximately 1.3 per cent of disequilibrium from the shock experienced in the previous year converges back to the long-run equilibrium in the current year, with a statistical significance of one per cent. Consequently, the outcomes suggest that petroleum exports exert both short-run and long-run impacts on the economic growth of India. Residual diagnostics tests require the probability value of Serial Correlation and Heteroskedasticity tests to be at the one per cent level. However, the results of the Normality test indicate an insignificant level. The representation of the results as a pair of straight lines indicates that the model remains stable throughout the same period. As a result, the study advises the government (policy makers) to focus on reducing the total costs, improving more refinery companies, and enhancing the competitiveness of India's petroleum exports.

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