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An Empirical Investigation into the Real GDP and Net Direct Investment in India: Insights from Unit Root Tests, Structural Break Analysis, and ARIMA of variables

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1. OBJECTIVE AND MOTIVATION OF THE STUDY

Introduction

Real Foreign Direct Investment (FDI) has emerged as a pivotal driver of economic growth, particularly in developing economies like India. This study delves into the intricate relationship between Real Gross Domestic Product (GDP) and Net Direct Investment (NDI) in India, aiming to uncover the long-term causal linkages and dynamic interactions between these variables.

By employing a rigorous empirical approach, we seek to provide valuable insights into the impact of NDI on India's economic growth. Our analysis involves a series of econometric techniques, including unit root tests to assess stationarity, structural break analysis to identify potential shifts in the relationship, and ARIMA modelling to capture the underlying time series patterns.

Through this comprehensive investigation, we aim to contribute to the existing body of knowledge on the role of NDI in economic development and provide policy implications for fostering sustainable growth in India.

Objective and Motivation

The primary objective of this study is to empirically analyze the relationship between real GDP and Net Direct Investment in India, focusing on their statistical characteristics, dynamic interactions, and the impact of structural changes. The motivation for this research lies in the critical role of NDI as a driver of growth in emerging economies and the need for a detailed examination of its influence on India’s economic performance.

By conducting unit root tests, the study aims to determine the stationarity of the time series data, which is a prerequisite for reliable modelling. Structural break analysis is employed to identify significant shifts in the relationship, often tied to pivotal events like economic reforms or global financial crises. ARIMA modelling provides a robust framework for forecasting the trends of GDP and NDI.

This comprehensive approach is driven by the broader goal of contributing to economic policymaking. By understanding how GDP and NDI interact, the study seeks to offer insights that can guide strategies for fostering sustainable growth, optimizing investment policies, and enhancing economic resilience in the face of global and domestic challenges. Through its findings, the paper aspires to bridge gaps in existing literature and provide actionable recommendations for academics, policymakers, and investors.

2. LITERATURE REVIEW

TITLE	AUTHOR	OBJECTIVE	METHODOLOGY	RESULTS
1) A Study on Impact of Foreign Direct Investment on Gross Domestic Production in India	Tamilselvan, M. and Manikandan, S.	To understand the impact of foreign direct investment on the gross domestic production in different nations through adequate review of literature. To estimate the cause and effect of foreign direct investment on gross domestic production in India during the study period using simple linear regression model addressing the ordinary least square assumptions such as serial correlation, heteroskedasticity and the normal distribution of residuals.	In the present study the secondary data was used to analyze the impact of foreign direct investment on the gross domestic production in India during the study period 1991-92 to 2013– 2014. The data has been retrieved from the RBI Website. To interpret the results of simple linear regression, Breusch-Godfrey Serial Correlation LM Test, Heteroskedasticity: White Test and Jarque Bera Normality Test was used to draw a conclusion.	The p-value of F-Statistic indicates the model is fit for the overall population. It ensured that the FDI is significantly influencing the GDP. The p-values of Breusch-Godfrey Serial Correlation LM Test, Heteroskedasticity: White Test and Jarque Bera–Normality Test respectively shows heteroskedasticity is not found, the residuals are normally distributed,
2) Impact of foreign Direct investment on employment and gross domestic product in India	Netrja Mehra	The objective of this study is to understand whether the creation of employment opportunities and an improvement in the GDP are dependent on the inflows of FDI in India. The conclusions of this study will help in understanding the involvement of FDI in increasing the GDP and improving employment opportunities in the country. This could also help in policy making for the currently tabled nation-wide debate on FDI laws in India, to form an effective policy to boost employment and growth opportunities.	The data for the multiple-regression model on FDI, employment and GDP will be obtained on an annual based frequency from the year 1970 to 2007, a total of 38 data points. The data collected will be secondary in nature and would be taken from the database of the RBI and the World Bank A multiple-regression method has been used to empirically analyse the correlation of the data sets of FDI, employment and GDP. In this study, four regression equations will be required. First, the impact FDI has on the GDP of India. Second, the impact FDI has on the employment generated in the public sector. Third, the impact FDI has on the employment in the private sector and lastly the impact of FDI on the total employment of the country.	A high kurtosis portraying that the variable has a low, even distribution and a chart with fat tails. a positive skewness indicating that estimation can be made of the future data points of these variables will be more than the mean. First equation shows Foreign Direct Investment does have a significant impact on dependent variable employment in the public sector, second equation show Foreign Direct Investment does have a significant impact on the dependent variable Employment in the private sector similar kind of results obtained in third and fourth equation in which independent variable impacting dependent variable significantly

3) Foreign direct investment and economic growth in India	R. ANITHA	This study is based on the following objectives- To compare FDI inflow during the post liberalization period with pre liberalization period and to forecast FDI inflow to India for a future period of 5 years. To identify the factors which influence the flow of FDI in India. To identify the problems relating to inflow of FDI and to make suitable suggestions for attracting more FDI inflow to India.	The study was based on published sources of data collected from various sources. The data was extracted from the following sources: Handbook of Statistics on the Indian economy, RBI, Economic Survey, Government of India, DIPP, CSO. The study was undertaken for a period of 30 years from 1980-81 to 2009-10. The Annual Growth Rate (AGR) and Compounded Annual Growth Rate (CAGR) are used to analyze the FDI inflows during the Pre and Post Liberalization period to find out the magnitude of FDI inflows. Further, ARIMA model is used to forecast FDI inflows.	CAGR which was 25.46 percent during Pre liberalization has increased to 34.73 percent during the Post liberalization period. This shows the openness of the Government in liberalizing and globalizing the economy to the outside world through relaxation of regulatory and entry restrictions on FDI inflows. In ARIMA results the p-value is constant, first and second lag is very less. This indicates that the fit is good. Further, the Alkaline's Information Criterion (AIC) and Schwarz's Bayesian Criterion (SBC) both measure goodness of fit and account for model complexity
4) Time Series Analysis of Foreign Direct Investment and Economic Growth: A Case Study of India	Gurmeet Singh	The aim of this paper was to investigate the relationship between the Foreign Direct Investment (FDI) net inflows (current US$) and Gross Domestic Product (GDP) (Current US$). The study uses yearly data over the period 1975 to 2013. Data for both macroeconomic variables is collected from the database of the World Bank website.	The present study employs the time series data analysis technique to study the relationship between the FDI and GDP. In a time series analysis, the results might provide a spurious if The data series are non-stationary. unit root is used for checking stationary and The Augmented Dickey Fuller (ADF) (1979; 1981) is performed to check the stationary nature of the series. lag length is selected based on LR Test and AIC with non-stationary series co-integration has been used to examine any long run relationships exist through Johansen approach, Granger Causality test (1987) was also performed	The presence of unit root indicates that the data series is non-stationary. in the Augmented Dickey Fuller (ADF) (1979; 1981) both the series are found to be non-stationary at level with an intercept Through Johansen procedure Both the trace statistic and the maximum eigenvalue statistics identify one cointegrating vector. The results show that a long-run equilibrium relationship exists between the FDI and GDP. The results show that the FDI granger causes GDP and GDP granger causes FDI.
5) Foreign direct investment and economic growth: empirical evidence from India	T. Mohanasundaram and P. Karthikeyan	This paper tries to examine the interrelationship prevails between FDI and GDP of India using the quarterly data available from various	Unit root test was used to examine whether a time series variable is stationary or non-stationary using an autoregressive model. The Granger causality test used a statistical hypothesis test for	Pearson's correlation analysis gives preliminary insight on the existence of co-movement among the time series variables; all the data series are non-stationary at levels and

		sources. The study was undertaken for a period of 14 years from 2000–2001 to 2014–2015. The data frequency used for the study period is quarterly data.	determining whether one time series is useful in forecasting another. The number of lags to be included was chosen using AIC OR SIC Cointegration was used to check many developments that can cause permanent changes in the individual variable, if there is some long-run equilibrium relation tying the individual variables together, and VAR Approach was also used	become stationary after first-order difference. The Granger causality test shows the null hypothesis of 'FDI does not Granger cause GDP' has been rejected confirming FDI Granger causes GDP. In Johansen's cointegration approach, both trace statistic and maximum eigenvalue statistics indicate no cointegration at 0.05 level, so it was concluded that there is no long-run relationship between FDI and GDP. VAR estimate shows that FDI is significantly influenced only by its own lag in short run
6) Is There Any Relationship Between Foreign Direct Investment, Domestic Investment and Economic Growth in India? A Time Series Analysis	Debashis Chakraborty and Jaydeep Mukherjee	Analyse whether there exists any long-run relationship between FDI, domestic investment and economic growth, and if so, what is the direction of the relationship.	Data includes quarterly data on GDP, gross (domestic) fixed capital formation (GFCF) and FDI for 1996 to 2009. They conduct ADF and PP unit root tests to check stationarity, alongside structural break tests (Lumsdaine-Papell, Lee-Strazicich). They use the Gregory and Hansen (1996) cointegration test to determine the existence and nature of any long-term relationship between the variables. They also do the ARDL causality test.	The long-run cointegrating relationship between FDI, GFCF and GDP in India is confirmed by the empirical analysis, there is a unidirectional causality from India's economic growth to FDI and from FDI to domestic investment. Higher FDI inflow in India in recent period can be argued to be facilitated by the relatively stable GDP growth rate, which in turn acted as a major boost towards a sustainable high domestic investment.
7) Economic Reforms, Foreign Direct Investment and its Economic Effects in India	Chandana Chakraborty and Peter Nunnenkamp	Assess the growth implications of FDI in India by subjecting industry-specific FDI and output data to Granger causality tests within a panel cointegration framework.	Unit root tests for FDI and output in a panel of 15 industries. They use the panel cointegration technique developed by Pedroni to test for a long-run cointegrated relationship between the two variables. Given the evidence of	The growth effects of FDI vary widely across sectors. FDI stocks and output are mutually reinforcing in the manufacturing sector. Any causal relationship is absent in the primary sector. They find only transitory effects of FDI on output in the services sector. These differences in the FDI-growth relations suggest that FDI is unlikely to work wonders in India if only remaining regulations

			cointegration in the long-run FDI-growth relationship across the panel, they use an error correction model to uncover Granger causality in the relationship in the final step of estimation.	were relaxed and still more industries opened up to FDI.
8) An Empirical Analysis of the Impact of Foreign Direct Investment on Economic Activity of India	R. Jayaraj and Sumeet Gupta	This empirical study has applied on an econometric model to examine the effect of FDI inflow on India's real economic activity using annual data for 27 observations from 1978 to 2008. Further it attempts to examine the impact of Liberalization policy (i.e. New Economic policy, 1991) on Indian economic activity after 1991.	The Stationary condition has been tested using ADF test. To examine the dynamic relationship between FDI activity and the growth of the economy VAR model is used. To further investigate the dynamic responses among the variables, the impulse response of the VAR has been calculated.	FDI did not Granger cause GDP but interestingly GDP has Granger cause on FDI. This result shows the inter-relationship between these two variables. GDP is positively influenced by its own activity, FDI and Liberalization. Both FDI and Liberalization moves in the same direction.
9) Time Series Analysis of Inward Foreign Direct Investment Function in Malaysia	Mohamed Ibrahim Mugableh	This paper investigates equilibrium relationships between FDI inflows and its determinants (i.e., broadest money supply, consumer price index, exchange rates, gross domestic product, and trade).	The paper employs unconditional error correction approach (i.e., the autoregressive distributed lag (ARDL) approach) to analyse long-run and short-run relationships among FDI, consumer price index, exchange rates, GDP, money supply, and total trade for the (1977−2012) period.	The variables are cointegrated in the FDI inflows function. However, the results of the ARDL approach suggest that exchange rates, gross domestic product, broadest money supply, and trade augment the flows of FDI into Malaysia, while consumer price index decline them. The observed findings reject the null hypothesis of no co-integration between the series. In addition, the results show that exchange rates, gross domestic product, broadest money supply, and trade have positive impact on FDI inflows.

10) The Impact of FDI Inflows on GDP Growth Rate and Unemployment Rate in India During 1991-2023	Debesh Bhowmik	The paper examined to relate the impact of FDI inflows in India on the unemployment rate and the economic growth as measured by GDP per capita during the study period from 1991 to 2023 using Johansen cointegration and vector error correction analysis.	The Data on FDI inflows, GDP per capita and unemployment rate as percent of total workforce for India were collected from the World Bank from 1991 to 2023. The behaviour of India's FDI inflows was studied by applying nonlinear trend, Hamilton's decomposition model and tested ARIMA(p,d,q) model	It has break unit root in 2005 and marches towards equilibrium through ARIMA (2,0,1) model. Johansen rank test confirms that FDI, unemployment rate and GDP per capita have two cointegrating equations in trace statistic and one cointegrating equation in max eigen statistic. The vector error correction model states that FDI have positive relation with GDP per capita and have negative relation with the unemployment rate.
11) Impact of Foreign Direct Investment on Economic Growth of India	Prof. Keerti Kulkarni, Dr. H.N.Shivaprasad, Dr. M M Munshi	The study examined the long- run and short- run impact of FDI on economic growth of India.	The paper uses the annual time series data from 1991-92 to 2018-19 extracted from Handbook of Statistics on Indian Economy and from Bulletin of Reserve Bank of India. The paper employs Unit Root Tests, ARDL of Cointegration and Structural Break tests.	The results indicate that economic growth accelerates and augments foreign direct investment inflows, which means that there is an existence of long-run relationship between economic growth and foreign direct investment in India,
12) Impact of FDI on GDP: A Comparative Study of China and India	Dr. Gaurav Agrawal	The paper attempts to investigate the effect of FDI on economic growth of China and India. The time period of the study is taken to be 1993-2009.	The paper employs modified growth model from basic growth model. The factors included in growth model were GDP, Human Capital, Labor Force, FDI and Gross Capital Formation, among which GDP was a dependent variable while the rest four were independent variables. The dataset for the relevant variables was collected from World Bank and UNCTAD for 1993-2009.	The study confirms that FDI promotes economic growth, and further provides an estimate that 1% increase in FDI would result in 0.07% increase in GDP of China and 0.02% increase in GDP of India. It was also found that China's growth is more affected by FDI than India's growth and FDI is not as significant as other variables to predict growth.
13) Macroeconomic Determinants of FDI: Evidence from India	Pami Dua, Reetika Garg	This study examines the macroeconomic determinants of FDI to India for the period 1997Q3 to 2011Q3 by looking into both domestic and foreign macroeconomic factors that are expected to influence FDI flows.	The main data sources are Handbook of Statistics and Current Statistics of RBI, International Financial Statistics of IMF and Federal Reserve Bank. This study estimates the long run macro econometric model to analyze the determinants of FDI flows to India including other tests such as Ng-Perron	The study indicates that all factors are conducive to FDI flows to India indicating us an attractive destination for FDI

			and DFGLS to test for non-stationarity, Log-likelihood test to test for cointegration, Granger causality tests, impulse response and variance decomposition analysis are employed.	
14) A Causal Relationship between Trade, Foreign Direct Investment and Economic Growth for India	G.Jayachandran, A. Seilan	This study investigates the relationship between Trade, Foreign Direct Investment (FDI) and economic growth for India over the period 1970-2007.	The data sources for analysis are annual, covering the period 1970- 2007 and are obtained from UNCTAD statistics 2008 and World Development Indicators – CD ROM 2008. The paper employs Unit Root Tests, Cointegration Test and Granger Causality Test to examine the direction of causality between the economic indicators.	The study indicates that there is no reciprocal causality between economic growth rate, FDI and Exports in India.

3. METHODOLOGY

We begin by determining appropriate lag length for the model including both the deterministic components i.e. intercept and trend. Specifically, we arrive at appropriate lag length by testing for serial-correlation in the residuals of the model. Then we conduct the steps of sequential procedure to determine which deterministic terms to include and also to draw our inference for the unit root.

We then run the test for structural break on the residuals of the model derived as a consequence of sequential procedure. On observance of Structural break, we conduct break- point unit root test using innovative outlier method since the graph shows a gradual break occurrence. If we observe no structural break then we go on to conduct Augmented Dickey-Fuller (ADF) test, Phillips-Perron test and Kwiatkowski-Phillips-Schmidt-Shin test statistic (KPSS) test and draw out relevant conclusions. We conducted Multiple Unit root tests for each variable. We also fit ARIMA models on both the variables.

Data Description

For the purposes of this study, we have chosen quarterly data of relevant variables from April, 1999 till March, 2024. The variables of our interest are Real GDP for India (at 2011-12 prices) (US$ Million) and Net Direct Investment in India (US$ Million) for each quarterly period. The data for Real GDP is sourced from Ministry of Statistics and Program Implementation (MOSPI) and the data for Net Direct Investment is sourced from The Reserve Bank of India. The data for Real GDP was available in three parts at different base year prices (1999-2000, 2004-05, and 2011-12). So, to compile the data, we converted all the data at the base prices of 2011-12 by using the conversion factors derived by using data for overlapping years in the three data sets. The data for real GDP was also in crore rupees as opposed to data for net direct investment which was in millions of US dollars. Thus, to maintain uniformity we also converted the data for real GDP in millions of US dollars using quarterly exchange rate data between the two currencies for the corresponding time periods. We get the data for exchange rate from the OECD database. The data for net direct investment was mostly available in millions of US$ but for a few quarters, the data was available in crore rupees so we also converted that into millions of US$.

All the data are obtained from:

- Real GDP: https://www.mospi.gov.in/data
- Net Direct Investment: https://m.rbi.org.in//Scripts/Statistics.aspx

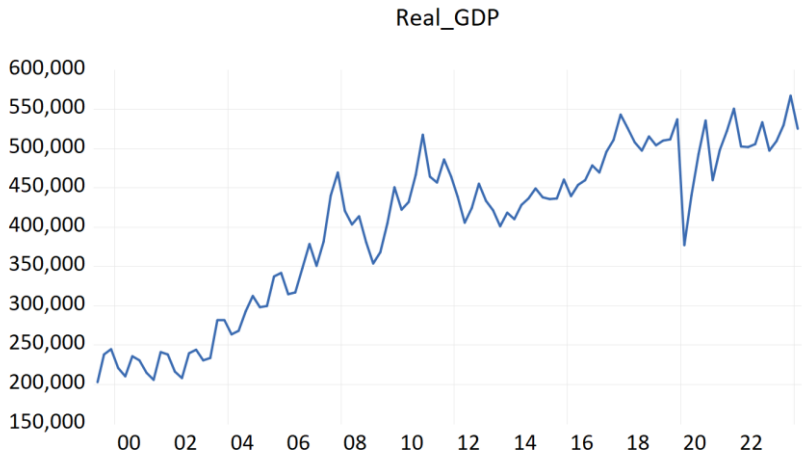
- Exchange Rates: https://fred.stlouisfed.org/series/CCUSMA02INQ618N

4. ANALYSIS AND FINDINGS

4.1 Testing the non-stationarity/stationarity of each variable - Unit Root Test

The first step in time series analysis is the unit root test. Under this test we need to determine the stationarity or non-stationarity of variables chosen. Generally, economic data of a stochastic time series or a trend is not stationary, meaning that the data have unit roots. Essentially, it suggests that the series has a long-term trend and does not revert to a constant mean over time. This can lead to spurious regression results and unreliable forecasts. So, in order to estimate a model using these data, we need to test the stationarity of the variables through unit root test.

REAL GDP



We begin our analysis by conducting multiple unit root tests. To be on the safe side we suspected our series to have three unit roots. The null of three unit roots and two unit roots are safely rejected at 5% level of significance by using respective tau distribution tables. But further testing for one unit root we test concluded the presence of one unit root at 5% level of significance.

Next, we conducted a sequential procedure to figure out the presence of any deterministic terms. To do that we first decide on the appropriate lag length to be included in the testing to eliminate any chance of specification bias. We conducted Bruesch Godfrey serial correlation LM test which concluded no serial correlation at up to 4 lags. Thus, selecting the appropriate lag length of 4.

We specified the appropriate model including intercept, four period lag term, trend term and appropriate differenced lag length. The coefficient of 4 period lagged real GDP (gamma) is not significantly different from zero using tau tau distribution at 5% level of significance concluding presence of unit root. Next, we check if the trend term is correctly specified using the fi3 distribution, by appropriately restricting the model with lag term and trend term excluded. The fi3 value turns out to be not statistically significant from zero concluding presence of unit root and absence of trend term. Now we estimate the model with intercept and check the significance of coefficient of 4 period lag real GDP variable, again null of unit root is not rejected at 5% level of significance using tau-mu distribution concluding presence of unit root. Again, we check for if the intercept is appropriately included by further restricting the model i.e. excluding the intercept and one period lagged term. Now calculating the value of fi1 and the null of presence of unit root and absence of intercept is not rejected hence concluding unit root and absence of intercept. Further we estimated a model without any deterministic term which concluded

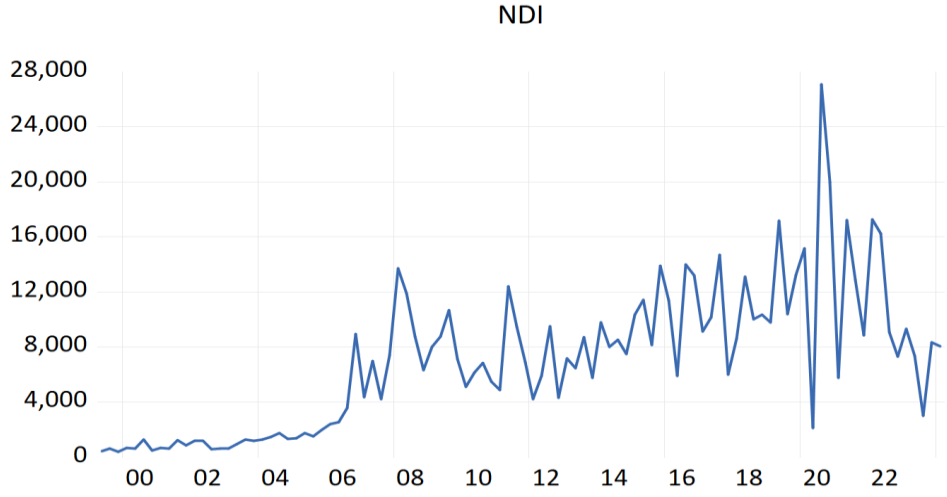
presence of unit root at 5% level of significance using tau distribution. Testing for structural break on residual with a model including intercept, the test safely concluded no structural break. Now we can conduct ADF, PP, KPSS tests.

We also check if residuals are heteroskedastic and find that null is not rejected and thus, residuals are homoscedastic

Conducting ADF test, at level we conclude presence of unit root and at first difference we find the series to be stationary. PP test too concluded presence of unit root at level and series being stationary at first difference. In the conformity test KPSS, the null of stationary is rejected at level and not rejected at first difference.

Thus, all tests at level with no deterministic term as suggested by sequential procedure concludes presence of unit roots at level and first difference being stationary. Hence, we conclude the Real GDP to be integrated of order 1.

NET DIRECT INVESTMENT IN INDIA (NDI)



We conduct multiple unit root tests suspecting presence of 3 unit roots. The test concluded the presence of 1 unit root at 5% level of significance. Next, we specify an appropriate model to determine lag length. We conducted Bruesch Godfrey serial correlation LM test which concluded no serial correlation at up to 2 lags. Thus, selecting the appropriate lag length of 2.

Conducting sequential procedures starting with a basic model including all the deterministic terms. Test concludes presence of unit root. Then checking if the trend term is correctly specified by restricting the model. We calculate the value fi3 which turns out to be not significantly different from zero concluding presence of unit root and absence of trend term. After eliminating trend term and estimating the model the null of unit root is not rejected at 5% level of significance. Now we check if the intercept term is correctly specified thus restricting the model the value of fi1 is not statistically significantly different from 0 thus presence of unit root and absence of intercept term. Now estimate the model without deterministic components which concludes the series having unit root. Next, we check for structural breaks for which we conduct Quandt Andrews unknown breakpoint test. The test concluded absence of any structural break.

We also check if residuals are heteroskedastic and find it to be so.

Conducting ADF test, at level we conclude presence of unit root and at first difference we find the series to be stationary. PP test too concluded presence of unit root at level and series being stationary at first difference. In the conformity test KPSS, the null of stationary is rejected at level and not rejected at first difference.

Thus, all tests at level with no deterministic term as suggested by sequential procedure concludes presence of unit roots at level and first difference being stationary. Hence, we conclude the Net Direct Investment to be integrated of order 1.

Variable	ADF Test Null: Unit Root		Phillips-Perron Null: Unit Root		KPSS Null: Stationarity		Inference
	Level	First Difference	Level	First Difference	Level	First Difference	
Real GDP	**1.078002**	**-4.180028**	**1.572814**	**-12.0811**	**1.092876**	**0.172783**	**I (1)**
NDI	**-0.620948**	**-16.8552**	**-2.213672**	**-17.49834**	**0.978087**	**0.073301**	**I (1)**
Note: t-stat is reported for ADF and Phillips -Perron test. LM Stat is reported for the KPSS test. All other results attached in Appendix							

4.2 ARIMA Modelling

Real GDP

This variable is integrated of order one. The correlogram of the 1st difference series shows spikes breaching the confidence interval at lags one for both ACF and PACF which for the next four lags was within but close to the confidence interval till five lags for ACF and four lags for PACF. So, we begin our ARIMA model specification as ARIMA (4,1,5). We fit all the possible combination of ARIMA structure and made observance of a total of six factors: R-squared, Adj. R-squared, Akaike-info criterion, Schwarz criterion, Durbin-Watson stat. and Correlogram. We look for the model which had highest R-squared and Adj.R-squared values, which has lowest Akaike-info criterion and Schwarz criterion value, whose Durbin-Watson stat. is close to two implying no serial correlation and whose correlogram doesn't shows any spikes beyond the confidence interval. From observational judgement both models ARIMA (4,1,4) and ARIMA (2,1,2) showed no serial correlation through correlogram and all the desirable properties. Still, ARIMA (4,1,4) beats ARIMA (2,1,2) in all the desirable factors. It has highest R-squared and Adj.R-squared values, has lowest Akaike-info criterion and Schwarz criterion value, its Durbin-Watson stat. is also close to two and its correlogram doesn't shows spikes at any lag breaching confidence limits among all the models evaluated. Thus, we conclude ARIMA (4,1,4) is the best model among all other models that explains the behaviour of Real GDP in the Indian economy.

ARIMA Models - Real GDP							
	(4,1,5)	**(3,1,5)**	**(4,1,4)***	**(3,1,4)**	**(2,1,3)**	**(2,1,2)**	**(1,1,1)**
R-squared	**0.330137**	**0.099552**	**0.448651**	**0.253701**	**0.251603**	**0.391707**	**0.140202**
Adj. R-squared	**0.308983**	**0.071117**	**0.431241**	**0.230133**	**0.227971**	**0.372498**	**0.113051**

Akaike-info criterion	23.24343	23.53226	23.08244	23.34611	23.34952	23.20087	23.48178
Schwarz criterion	23.34838	23.63711	23.18729	23.45097	23.45437	23.30572	23.58663
Durbin-Watson stat.	2.059446	2.171711	2.098815	2.115025	2.360204	2.496535	1.871896
Correlogram	No Serial Correlation	No Serial Correlation	No Serial Correlation	No Serial Correlation	No Serial Correlation	No Serial Correlation	No Serial Correlation
* ARIMA (4,1,4) has the highest R-squared & Adj. R- squared, has the lowest AIC & SIC and value of Durbin- Watson stat close to 2.							
Note: Rest of the models are estimated and attached in the Appendix							

Net Direct Investment

We do a similar exercise for this variable as NDI is also integrated of order 1. The correlogram of the 1st difference series shows spikes breaching the confidence interval at lags one for both ACF and PACF which for the next four lags was within but close to the confidence interval till five lags for ACF and three lags for PACF. So, we begin our ARIMA model specification as ARIMA (3,1,5). We fit all the possible combination of ARIMA structure and looked for similar factors again. ARIMA (1,1,2) showed the best results with ARIMA (1,1,1) coming at second best. It has highest R-squared and Adj.R-squared values, has lowest Akaike-info criterion and Schwarz criterion value, its Durbin-Watson stat. is also close to two and its correlogram doesn't shows spikes at any lag breaching confidence limits among all the models evaluated. Thus, we conclude ARIMA (1,1,2) is the best model among all other models that explains the behaviour of Net Direct Investment in India.

ARIMA Models - NDI							
	(3,1,5)	(2,1,5)	(1,1,5)	(1,1,4)	(1,1,3)	(1,1,2)*	(1,1,1)
R-squared	0.233306	0.082806	0.217055	0.242041	0.297053	0.468186	0.436145
Adj. R-squared	0.209094	0.053842	0.192331	0.218105	0.274855	0.451392	0.418339
Akaike-info criterion	19.55648	19.72617	19.56841	19.53813	19.46187	19.19184	19.24696
Schwarz criterion	19.66133	19.83103	19.67326	19.64298	19.56673	19.29669	19.35182
Durbin-Watson stat.	2.774491	3.058746	2.539444	2.480778	2.349148	2.264727	2.07834

Correlogram	**No Serial Correlation**	**Serial Correlation**	**No Serial Correlation**	**No Serial Correlation**	**No Serial Correlation**	**No Serial Correlation**	**No Serial Correlation**
*** ARIMA (1,1,2) has the highest R-squared & Adj. R- squared, has the lowest AIC & SIC and value of Durbin-Watson stat close to 2.**							
Note: Rest of the models are estimated and attached in the Appendix							

5. CONCLUSION

Through a comprehensive analysis of two key variables related to the Indian Economy—Real GDP and Net Direct Investments in India—we have gained valuable insights into their underlying dynamics and characteristics. Beginning with the real GDP, our unit root test and sequential procedure revealed the presence of a unit root, indicating integration of order 1. Despite variations in methodology, the consistent presence of a unit root indicates robustness of the test. The variable also follows an ARIMA (4,1,4) structure. Moving on to the NDI, our analysis unveiled the presence of a unit root indicating integration of order 1. The variable also follows an ARIMA (1,1,2) structure.

This study has delved into the intricate relationship between Real GDP and Net Direct Investment in India. By employing a rigorous empirical approach, we have gained valuable insights into the dynamic interplay of these variables. These findings contribute to a deeper understanding of the factors driving India's economic growth and development.

The results of this study can be used to inform policymakers and researchers in developing effective strategies for sustainable economic growth in India. Furthermore, the methodologies employed in this study can be applied to other countries to gain insights into the relationship between NDI and economic growth in different contexts.

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