Foreign Capital and Sustained Growth Nexus in India

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Abstract

This study is a major departure from the traditional analysis of the impacts of macroeconomic variables on mere growth of GDP or GNI. The perception of sustained growth instead of growth of GDP incorporated depletion of natural environment on the growth process. This study explores that long run equilibrium relationship (co-integration) prevails among foreign direct investment, adjusted growth, gross fixed capital formation, foreign aid, imports and spot exchange rate. In the short-run, adjusted growth positively impacts foreign direct investment, gross fixed capital formation and imports of goods and services. But gross fixed capital formation negatively affects foreign direct investment in India. Adjusted growth affects and is affected by change in exchange rates. However, in the short-run, sustained growth is not affected by foreign direct investment, gross fixed capital formation, foreign aid, imports and exchange rate. COVID-19 pandemic has hindered the performance of Indian economy in 2020, but the economy rebounded immediately by the following year. Foreign direct investment to GDP ratio remained at very lower level despite the implementation of several FDI liberalization policies. Investment and foreign trade policies of the country require special attention for the achievement of sustained growth.

Keywords: *co-integration, foreign direct investment, make in India, official development assistance, sustained growth*

JEL: *C13, E22, F35, F43, Q56*

I. Introduction

Indian economy is a large and growing economy located in South Asian region with second largest population following Chinese Republic. The economy registered a soaring growth rate of 6.8 per cent in gross domestic product (GDP) in the year 2017. This growth rate marginally decreased to 6.5 per cent in 2018 and a bleak 3.7 per cent in 2019. COVID-19 pandemic and its obvious consequences pulled this growth rate down to minus 6.6 per cent in 2020, which is the lowest recorded growth in India (Asian Development Bank, 2022). However, the economy immediately begins to rebound and this growth rate magically increased to 8.9 per cent in 2021. The countries at the global level are inevitably keen to sustained growth in place of current growth of GDP. GDP hardly manifest depreciation and depletion of manufactured and natural capital. The sustained growth (adjusted growth) stands for growth of national income on deduction of damage to manufactured and natural capital from GDP. Flow of income of a

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nation depends on its produced capital, human resource as well as natural (renewable and non-renewable) capital. Total wealth accounting comprises produced capital, natural capital, intangible capital (human, social, and institutional capital) and net foreign financial flow of assets (World Bank, 2011). The long term sustained growth of an economy necessitates maintenance of proper portfolio of these assets. Sustained growth of an economy is essential precondition for sustainable development of that country. Therefore, this paper emphasises investigation of linkage between sustained growth and some selected macroeconomic variables. Major source of domestic capital formation is domestic savings. Foreign capital, however, plays a dominant role for capital formation. In a modern open economy, foreign capital enters the domestic economy in the form of foreign portfolio investment, foreign direct investment (FDI) and foreign aid (foreign loans and grants). Many research studies explored that the links between GDP growth rate and that of foreign investment and foreign aid is prominent. Those studies, however, excluded the pertinent issues of sustainability of the growth process. If natural capital exhaust in near future, growth process will face a grinding halt.

Foreign trade used to play a pivotal role in the regime of mercantilism (development based on exports of primary products to the European colonies and accumulation of bullions from those colonies). In the modern era of globalization (full exposure of domestic market forces to the international market forces), foreign trade has emerged as an engine of economic growth. Countries implement export-led and import-led growth strategies. Export growth promotes economic growth through the earning of foreign currency which, in turn, is utilised for import of essential inputs, raw materials and capital goods. Imports are crucial for access to foreign resources that complement utilization of domestic resources and enhance domestic production, productivity and efficiency (Moitra and Chakraborty, 2021). Indian economy has followed import-led growth strategies in its early phases of planned development to fulfil the needs of raw materials, equipment and the technical knowhow for the newly set up industries. But the economy pursued export-led growth strategies at the later phases of its planned development. Export earns foreign exchange which is indispensable for the imports of crude oil and other essential equipment. Foreign aid is an important determinant for economic growth. Available research studies show that the impacts of foreign aid on domestic savings or income are positive for some research studies and negative for the rest (Chenery and Strout, 1966; Griffin and Enos, 1970; Burside and Dollar, 2000; Levine and Roodman, 2004; Mohmoud M. Sabra, 2021). Foreign debts imposes financial burden for the repayments of principal and interests for the receipt of foreign aid. This research investigates the impacts of foreign aid on the other macroeconomic variables in India.

This research considers the variables, namely, foreign direct investment, sustained growth, gross fixed capital formation, foreign aid, imports and spot exchange rate to be endogenously determined. Annual time data have been collected from various secondary sources. In order to detect various properties of individual time series data, standard statistical tests have been pursued. Vector Error Correction model has been fitted for time series data. Granger causality tests and variance decompositions were performed to ascertain the results of vector error correction model. Investigation of both short run and long run dynamic relations among the concerned time series data for India explored some interesting results.

II. Literature Review

Harrod-Domar growth models (Harrod, 1948; Domar, 1947), the classical models of economic growth, provide framework for the investigation of links between aggregate output and required accumulation of capital. The first application of these models to divulge the impact of foreign aid on economic growth was undertaken by Chenery and Strout (1966) in their

outstanding two gap models- the savings-gap model and the trade-gap model. The studies delineate that foreign aid is effective (influences economic growth) through the fulfilment of these two gaps. In a seminal study conducted by Burnside and Dollar (2000), it was explored that foreign aid has a positive impact on economic growth (effective) in developing countries possessing sound fiscal policy, monetary policy and trade policy environments, but has little effect in the presence of poor policy circumstances. Easterly, Levine and Roodman (2004), however, cautioned the economists and the policymakers to be less confident on the effectiveness of foreign aid even in a good policy set up.

Sabra (2021) undertook a study of seven middle income countries, namely, Algeria, Egypt, Jordan, Lebanon, Morocco, Palestine, and Tunisia covering the period of 2000-2019. The study finds out that official development assistance (ODA) crowds out local savings but raises volume of imports. In India, foreign aid has promoted both economic growth and economic development during the period 1975-76 to 2009-10 (Sahoo and Sethi, 2013). In an empirical study (Sethi et al. 2019) the researchers applied the tools of time series data analysis for testing causality among selected macroeconomic variables. The study unveiled that long run causality persists among the macroeconomic variables, namely, foreign trade, financial development, domestic investment, inflation rate, official development assistance and per capita gross domestic product. A very recent study by Ono and Sekiyama (2024), following survey method, found out that Japanene ODA to India have positive impact on Japanese FDI inflows in India. The COVID-19 pandemic has changed the pattern of sectoral allocation of foreign aid. A research study undertaken by Brown (2021) detected that the COVID-19 pandemic raised the requirement of public goods (medical facilities and COVID-19 vaccines) worldwide in lieu of investments in infrastructure.

Foreign aid, concessional debts and domestic savings are positively linked to the inflow of foreign direct investment (FDI) in African countries during the period 1993-2011 (Teng, 2021). In India, a log-run relationship among economic growth, foreign aid, foreign direct investment and inflow of remittances has been found for the period 1960-2016 (Das and Sethi, 2020). The statistical analysis of Ibrahim (2021) vindicates that the total inflows of foreign direct investment in India marks positive impact on GDP and net national income (NNI). Investment by some foreign companies till the financial year 2020-2021 was $901 billion. This hike in investment in India would increase GDP by 5.68 per cent over the next 10 years (Jaswal et al., 2022).

Institutional quality is an important determinant for the inflow and effectiveness of FDI in India. Regression analysis for balanced panel of 20 countries over the period 2006-2019 shows that the institutional reforms which facilitates the Ease of Starting Business score (a proxy for entry-focused regulations imposed on multinational corporations by the government) improved from 26.8 in 2006 to 81.2 in 2019, which significantly and positively influences FDI inflows (Kaushal, 2021). Make in India project (a national mega-project introduced by the Prime Minister of India on 25th September, 2014 for the encouragement of production by domestic and foreign companies in 27 selected sectors) affirms that Ease of Doing Business (measure of regulatory environment to business operations) index has improved for last five years, but FDI inflows as a percentage of GDP remained relatively flat during the study period (Nagarjuna, 2022).

Environmental threats emanated from climate change and global warming is a matter of great concern that persuaded the researchers to investigate the association between economic entities and the environmental issues. Kaur (2017) pinpointed that foreign direct investment in India is generating growth opportunities accompanied with increasing environmental degradation.

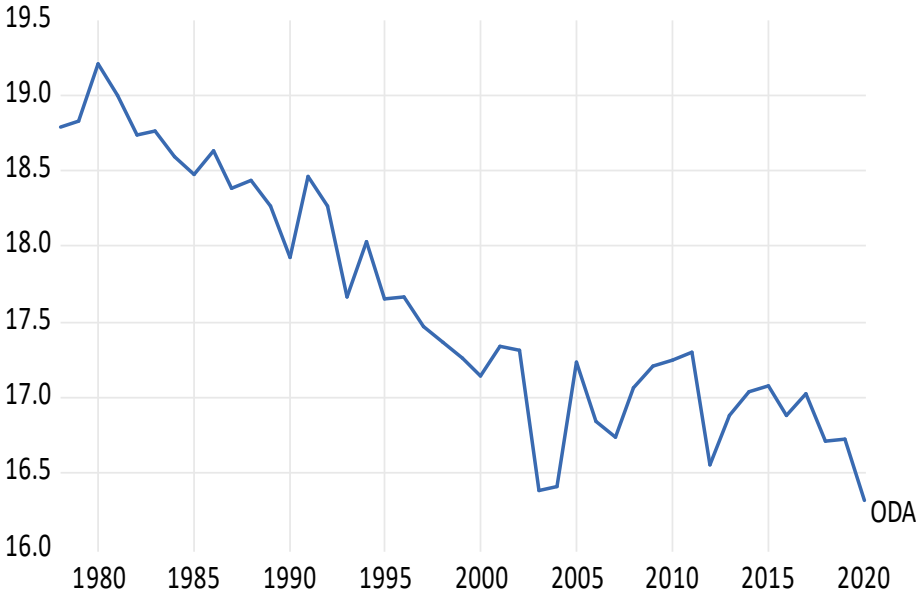
Panel co-integration test, dynamic ordinary least squares (DOLS) and vector error correction model (VECM) for the SAARC countries explored that causal interaction prevails with carbon emissions and foreign direct investment and economic growth (Latief et al., 2021).
Doytch et al. (2024) investigate the impact of FDI in various sectors in the economy on the rates of change of forest cover and on the ecological footprint measured in forest land. The study explores that FDI in agriculture, mining, manufacturing, and construction have negative effects on forest land. Mohanty, Sahoo and Chaudhury (2020) constructed eco-macroeconomic performance index (Eco-MEP) for India incorporating climate change and pollution augmenting variables to the macroeconomic variables. Their study finds out that, after 2000, environmental factors have harmed overall performance of Indian economy. Sharmiladevi (2024) employed ARDL bouds testing approach for finding long run relationship between FDI inflows and carbon dioxide emissions, GDP and trade openness. This study finds that long-run equilibrium results are significant for GDP and trade openness and that an increase in FDI inflow will always lead to an increase in carbon dioxide emission in India.
The review of foregoing literature indicates that most of the studies ignored the issues of sustainability of development process and concentrated merely on macroeconomic performances. Environmental issues were incorporated in macroeconomic analyses in few numbers of studies. Sustainable development being major principle of development to date, consideration of environmental issues is reflected in sustained growth of Indian economy. If the growth process become sustained, the development process is likely to be sustainable.

III. Current State of Specific Macroeconomic Variables in India

Adjusted Net National Income: Adjusted net national income is calculated by the World Bank (and the other agencies) following the wealth accounting methodology incorporated in the report entitled *The Changing Wealth of Nations: Measuring Sustainable Development in the New Millennium* (World Bank, 2011). Adjusted NNI is calculated from gross national income on deduction of consumption of manufactured (fixed) capital (value of machinery, structures and equipment) and the value of depletion of environmental capital (agricultural land, protected areas, forests, minerals, and energy). Growth rate of adjusted net national income is calculated from constant price series deflated using the gross national expenditure deflator. It has been meanwhile mentioned that growth of this adjusted NNI has been coined sustained growth. In the year 2010, adjusted net national income in India was 1350,000 million US dollars, which increased to 2200,000 million US dollars in 2020 (World Bank, 2022).
Net Official Development Assistance and Official Aid Receipt: The Development Assistance Committee (DAC) of the Organization for Economic Co-operation and Development (OECD) referred official development assistance (ODA) to financial flows in DAC list of recipient countries and to multilateral institutions aiming at economic development of developing countries with grant element of at least 25 per cent (OECD, 2022). However, as per the new norms of concessions introduced in 2018, grant components were changed for the countries depending on their level of development.

In 2014, net receipts of external assistance from DAC countries and multilateral institutions stood at 17,676.4 million US dollar. These receipts increased to 23,999.5 million US dollar in 2019, but radically decreased in the following year. This drastic reduction is immediate aftermath of COVID-19 pandemic and paradigm shift of priority of investment from infrastructure development to health and wellbeing (Brown, 2021). Out of total ODA disbursement of 6650.9 US dollar in 2020, the highest share (3373.4 million US dollar) was anticipated in economic infrastructure and social service sector. The disbursement in transport and communication sectors was 3,180.8 million US dollar and that in social infrastructure and

service sector was 2620.8 million US dollar. Trade and tourism sector registered the lowest share of only 0.8 million US dollar (OECD, 2022a).



Source: Drawn by the author using Eviews 13

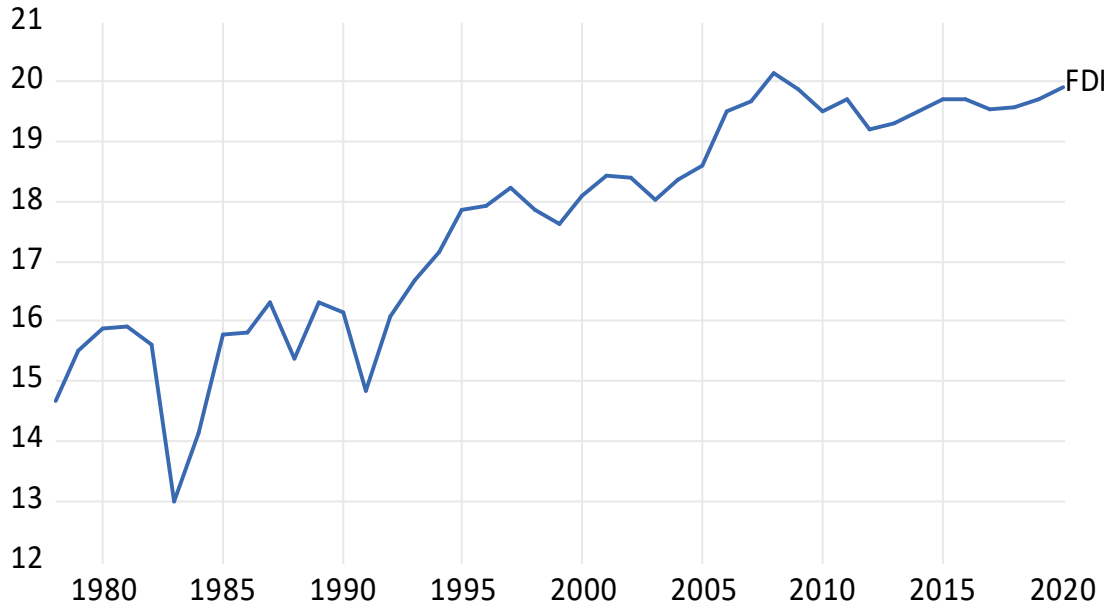
Figure-1: Official Development Assistance and Official Aid Received during 1978-2020.

Gross Fixed Capital Formation (GFCF) and Foreign Direct Investment (FDI): Gross fixed capital formation (gross addition to fixed assets like machineries, equipment and intangible assets) indicates the investments of the economy. The volume of GFCF was Rupees 25369,360 million in 2010-11, which increased to Rupees 68779,140 million (advance estimate) in India for the financial year 2021-22 (Government of India, 2022). In 2020-21, gross fixed capital formation in India recorded 31.2 per cent of gross domestic product compared to 32.5 per cent in 2019-20. GFCF is considered to be major determinant for growth of the economy. At the same time, it has environmental consequences, particularly in the developing countries, where bulk of national asset is natural resource.

Foreign Direct investment refers to foreign investment made by a resident in one country with a lasting interest in an enterprise located in other economies (OECD, 2008). FDI is the sum total of equity capital, re-investment of earnings as well as other long-term capital and short-term capital. World Investment Report 2022 of the United Nations Conference on Trade and Development (UNCTD) shows that FDI inflow in India was 44,481 million dollar in 2016, which increased to 64,072 million dollar in 2020, but decreased again to 44,735 dollar in 2021 (UNCTD, 2022).

As part of the inception of New Economic Policy (NEP) introduced in India in 1991, a number of FDI liberalization policies have been implemented. These policies encompass abolition of industrial approval system in all industries other than strategic or environmentally sensitive industries, automatic approval of 51 per cent FDI in 34 high priority industries, abolition of mandatory technology transfer agreements and establishment of Foreign Investment Promotion Board (Reserve Bank of India, 2022). The central government in India recently has increased the limit of FDI inflows in various Sectors of the economy (Muneeswaran and Vethirajan,

2022). These policy changes, however, do not document any radical change (no structural break) in FDI inflows as indicated by Figure-1.



Source: Drawn by the author using Eviews 13

Figure-2: Growth Trajectory of FDI in India over the Period 1978-2020.

Similarly, the global financial crisis of 2008-2009 has no noticeable effects on FDI inflows. Despite the inception of several FDI liberalization policies, ratio of FDI to DGP remained less than three percent over the entire study period. Strict countrywide lockdown in 2020 for COVID-19 pandemic has also not registered any adverse impact on inflows of FDI in India (although GDP growth rate was negative) for the year 2020. But the inflow of FDI decreased in the following year when GDP growth rate was very high (6.9 percent).

External Trade: During the financial year 2010-11, total exports of goods and services were 251,136.2 million US dollar and total imports of goods and services were 369,769.1 million US dollar, registering a negative balance of trade (-118,632.9 million US dollar). After a decade, this export radically increased to 422,004.4 million US dollar and imports reached 613,052.1 million US dollar in 2021-2022. Adverse valance of trade has substantially widened to -191,047.7 million US dollar (Reserve Bank of India, 2022a). However, balance of payments has been favourable due to capital account surplus (overall balance being 47,501 million US dollar in 2021-22).

Total external debt outstanding for 2010 was 290,428 million US dollars, which increased to 564,179 million US dollar in 2020. Total debt service on external debt (repayment of long run principal and payment of interest) in 2010 was 23,693 million US dollar. Of which, 19,018 million US dollar was repayment of principal and 4,675 million US dollar was payment to interest. Total debt service increased to 75,162 million US dollar in 2020. Of which, 63,970 million US dollar was repayment of principal and 11,192 million US dollar was payment to interest (IMF, 2022). It is observed that debt services have increased by three times in the last decade.

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IV. Data and Research Methodology

Data: This research is contingent on annual data for India spanning the period from 1978 to 2020. Data on macroeconomic variables, namely, net foreign direct investment (FDI), adjusted net national income (ANNI), gross fixed capital formation (GFCF), net official development assistance and official aid received (ODA), imports of goods and services (IMP) and spot exchange rate (EXCH) has been collected from the World Bank open data source (available at *www.worldbank.org*). Export was excluded from the model because it is statistically not significant. FDI, ANNI, GFCF, ODA, IMP and EXCH series at 2015 US dollar were divided by GDP deflator. Transformation of time series data into natural logarithm was accomplished for the elimination of nonlinear components. The difference operator 'Δ' connotes the first difference of the level series. Therefore, ΔFDI, ΔANNI, ΔGFCF, ΔODA, ΔIMP and ΔEXCH indicate first difference of FDI, ANNI, GFCF, ODA, IMP and EXCH, respectively. The first lag of the series has been marked by (-1) and the second lag by (-2). For example, ΔANNI (-1) indicates first lag of ΔANNI and ΔANNI (-2) implies second lag of ΔANNI. This paper is completely non-technical and puts forward results of various tests only.

The Model: In the Harrod–Domar model, output (Y) growth is proportional to incremental capital–output ratio (v),

$$Y=vK \qquad (1)$$

where K= capital stock. Differentiating equation (1) w.r.t. time (t) and dividing by Y, yields the equation of growth rate (g)

$$g = \frac{\dot{Y}}{Y} = v.\frac{dK}{dt}.\frac{1}{Y} = v.\frac{I}{Y} [I = dK/dt = \text{investment}] \qquad (2)$$

In this model, foreign aid (ODA), Foreign Direct Investment (FDI) and other sources of capital inflows is captured in the planned investment identity

$$I = S_d + ODA + FDI + OF \qquad (3)$$

where S_d = domestic savings, A= inflow of foreign aid and OF =other sources of capital inflows. Assuming Savings-investment equality and GFCF being resident producers' investment,

$$I = GFCF + ODA + FDI + OF \qquad (4)$$

Equation '2' and equation '4' establishes the link between growth and the other macro-economic variables under consideration.

In view of the growth model of equation (2), our basic model takes the functional form:

$$f\{\log(FDI)\} = f\{\log(ANNI), \log(GFCF), \log(ODA), \log(IMP), \log(EXCH)\} \qquad (5)$$

Since all our concerned variables are integrated of order one, appropriate VEC model is

$$\Delta \mathbf{Z}t = \boldsymbol{\delta} + \sum_{\mathbf{j=1}}^{\mathbf{k-1}} \Pi_j \Delta \mathbf{Z}_{t-j} + \phi \mathbf{Z}_{\mathbf{t-1}} + u_t \qquad (12)$$

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derived (by differencing and with some manipulation) from the basic VAR model proposed by Sims(1980),

$$\mathbf{Z}_t = \boldsymbol{\delta} + \mathbf{A}_1 \mathbf{Z}_{t-1} + \mathbf{A}_2 \mathbf{Z}_{t-2} + \mathbf{A}_3 \mathbf{Z}_{t-3} + \dots\dots\dots + \mathbf{A}_k \mathbf{Z}_{t-k} + \mathbf{u}_t \quad (13)$$

where $\mathbf{Z}t$ = {FDI, ANNI, GFCF, ODA, IMP, EXCH}′ kx1 vector of indigenous variables

k= number of indigenous variables (k=6 in our model)

$\boldsymbol{\delta}$ = {$\boldsymbol{\delta}_1$, $\boldsymbol{\delta}_2$, $\boldsymbol{\delta}_3$, $\boldsymbol{\delta}_4$, $\boldsymbol{\delta}_5$, $\boldsymbol{\delta}_6$}′ vector of fixed intercepts

$\boldsymbol{\Pi}$ = kxk matrix of autoregressive coefficients

$\boldsymbol{\phi}$ = {ϕ_1, ϕ_2, ϕ_3, ϕ_4, ϕ_5, ϕ_6}′ kx1 vector of speed of adjustment parameters

ECT_{t-1} = error correction term

$\mathbf{u}_t$ = {u_1, u_2, u_3, u_4, u_5, u_6}′ kx1 vector of white noise error terms

Target variable in equation (12) is FDI. Therefore, in scalar natation, the error correction model of FDI equation is

$$\Delta\log(\text{FDI}) = \delta_1 + \sum_{i=1}^{k-1} \alpha_i \Delta\log(\text{FDI})_{t-1} + \sum_{j=1}^{k-1} \beta_j \Delta\log(\text{ANNI})_{t-j} + \sum_{m=1}^{k-1} \gamma_m \Delta\log(\text{GFCF})_{t-m} + \sum_{l=1}^{k-1} \omega_l \Delta\log(\text{ODA})_{t-l} + \sum_{n=1}^{k-1} \theta_n \Delta\log(\text{IMP})_{t-n} + \sum_{p=1}^{k-1} \varphi_p \Delta\log(\text{EXCH})_{t-p} + \phi_1 \text{ECT}_{t-1} + u_t \quad (14)$$

Unit Root Tests: Three different types of stationarity tests, such as Augmented Dickey-Fuller (Dickey and Fuller, 1979) test, Philips-Peron (1988) tests and Kwiatkowski, Phillips, Schmidt and Shin (KPSS, 1992) tests have been conducted for detecting the order of integration of the variables.

The Augmented Dickey-Fuller regression with intercept and trend of order p is given by:

$$\Delta y_t = \alpha + \lambda(1-\theta)t - (1-\theta)y_{t-1} + \sum_{i=1}^{T} \phi_i \Delta y_{t-i} + u_t \quad (15)$$

where T is selected such that the residuals (u_t) are serially uncorrelated. T is selected on the basis of the Akaike information criterion (AIC) or the Schwarz criterion. In case of the null hypothesis (H_0) of non-stationarity, $\Delta y_t = u_t$.

The Philips-Peron tests corrects for the effect of residual serial correlation in a simple Dickey-Fuller regression ($\Delta y_t = a + by_{t-1} + u_t$) using non-parametric estimates of the long-run variance. The pp test statistics is given by (Pesaran, 2015):

$$Z_{\tau,df} = \left(\frac{S_T}{S_{LT}}\right) DF_\tau - \frac{\frac{1}{2}\left(S_{LT-}^2 - S_T^2\right)}{S_{LT}\left[\frac{\sum_{t-1}^{T}\left(S_{LT}^2 - S_T^2\right)^2}{\left[\frac{\sum_{t-1}^{T}(y_{t-1} - \bar{y}_{-1})^2}{T^2}\right]^{\frac{1}{2}}}\right]} \quad (16)$$

Where, DF_τ = Dickey- Fuller statistic

$$S_T^2 = \frac{\sum_{t=1}^{T} \hat{u}_t^2}{T}$$

$$S_{LT}^2 = \hat{\gamma}_0 + 2\sum_{j=1}^{m}\left(1 - \frac{j}{m+1}\right)\hat{\gamma}_j$$

$$\bar{y}_{-1} = \frac{1}{T}\left[\sum_{t=1}^{t-1} y_{t-1}\right]$$

In the Kwiatkowski, Phillips, Schmidt and Shin (KPSS, 1992) test, null hypothesis is of stationarity. In the KPSS test, a time series can be decomposed in to the sum of deterministic trend βt, a random walk r_t and a stationary error term ε_t:

$$y_t = \beta t + r_t + \varepsilon_t, \; r_t = r_{t-1} + u_t \qquad (17)$$

where u_t is white noise error term with a zero mean and variance σ_u^2. In case of testing level stationarity, βt term is excluded from the above equation. To test the hypothesis

$$H_0 : \sigma_u^2 = 0 \text{ (stationary time series)}$$

$$H_A : \sigma_u^2 \neq 0 \text{ (non - stationary time series)}$$

Kwiatkowski et al. used one-sided LM statistics. Theoretical exposition of KPSS statistics is beyond the scope of this paper. This is to be noted that the Bandwidth (lag lengths) for Philips Perron (PP) test and KPSS tests were chosen by Newey-West method using Bartlett Kernel. KPSS tests possess good size and power properties, which is an essential property for testing stationarity in the case of near-stationary processes.

Co-integration Test: Johansen (1988) co-integration tests have been pursued for the detection of co-integration among the endogenous variables. From equation (12) equation (13),

$$\phi = -\left(1 - \sum_{j=1}^{k} A_j\right)$$

$$\Pi_j = -\sum_{i=j+1}^{k} A_i \text{ for j= 1, 2, 3,…….k-1.}$$

We can obtain the estimates of ϕ and its characteristic roots. If $\mathbf{Z}_{t-1} \sim I(1)$, and its linear combinations $\boldsymbol{\phi}\mathbf{Z}_{t-1}$ are covariance stationary, such as $\boldsymbol{\phi}\mathbf{Z}_{t-1} \sim I(0)$, the VAR model in equation (13) is said to be cointegrated.

The test for the number of characteristic roots that are insignificantly different from unity can be performed using the trace statistics $\gamma_{trace}(r)$ and maximum Eigen value statistics $\gamma_{max}(r, r+1)$ as follows:

$$\gamma_{trace}(r) = -T\sum_{i=r+1}^{n} ln(1 - \hat{\gamma}_i)$$

$$\gamma_{max}(r, r+1) = -Tln(1 - \hat{\gamma}_{r+1})$$

where $\hat{\gamma}_i$= the estimated values of the characteristic roots (also called eigenvalues) obtained from the estimated π matrix, and T = the number of usable observations. These two statistics assist in determining the number of co-integrating regressions.

Results of the VEC model have been affirmed by the results found from VEC Granger causality (Block erogeneity) Wald test and that of variance decompositions. Residual based stability tests, namely, cumulative sum of residuals (CUSUM) and cumulative sum of squared residuals (CUSUM-square) have been pursued to show that the estimated parameters of the model are stable.

V. Results of Empirical Tests

Normality of the Series: Jarque-Bera (1987) normality test was performed for the verification of normality of the concerned series. The null hypothesis of Jarque-Bera normality test is that the variable under consideration is normally distributed.

Table-1: Results of Jarque-Bera Test

Variables	Skewness	Kurtosis	Jarque-Bera	Probability
FDI	-0.49	2.18	2.91	0.23
ANNI	-0.46	1.70	4.52	0.10
GFCF	0.02	1.76	2.77	0.25
ODA	0.29	1.85	3.00	0.22
IMP	0.41	1.45	5.51	0.06
EXCH	-0.64	1.96	4.82	0.09

Source: Calculated by the author using Eviews 13.

The value of Jarque-Bera statistics (Table-1) are very low and the corresponding probabilities are greater than 0.05 (statistically not significant). Therefore, the null hypothesis of normally is accepted. The series FDI, ANNI, GFCF, ODA, IMP and EXCH are normally distributed.

Stationarity: The test statistic for the ADF test is the τ-stat, while PP statistics and LM statistics are the test statistics for the Philips-Perron and KPSS tests, respectively. In the test equation, intercept term as well as intercept and trend terms were included.

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Table-2: Results of ADF, Phillips-Perron and KPSS Unit Root Tests

	ADF				Philips-Perron				KPSS	
Series	τ-stat^{C}	Prob.	τ-stat^{C,T}	Prob.	PP^{C}	Prob.	PP^{C,T}	Prob.	LM^{C}	LM^{C,T}
FDI	-1.45 (0)	0.55	-3.28 (0	0.8	-1.21 (6)	0.66	-3.36 (2)	0.07	0.77* (5)	0.13*** (3)
ANNI	-1.04 (0)	0.73	-1.34 (0)	0.86	-1.25 (3)	0.64	-1.39 (2)	0.85	0.22 (5)	0.19** (5)
GFCF	0.93 (0)	0.77	-1.52 (0)	0.81	-1.12 (3)	0.69	-1.69 (3)	0.74	0.44*** (5)	0.152** (5)
ODA	-1.21 (2)	0.66	-3.47 (0)	0.06	-0.76 (3)	0.82	-3.45 (3)	0.06	0.77* (5)	0.16** (5)
IMP	-0.83 (1)	0.80	-1.85 (1)	0.66	-0.81 (3)	0.81	-1.52 (3)	0.81	0.63** (5)	0.15*** (5)
EXCH	-1.77 (0)	0.39	-0.73 (0)	0.96	-1.54 (3)	0.50	-1.02 (3)	0.93	0.76* (5)	1.86* (5)
ΔFDI	-5.40* (5)	0.00	-5.87* (5)	0.00	-9.19* (15)	0.00	-9.04* (15)	0.00	0.19	0.17
ΔANNI	-5.79* (0)	0.00	-6.03* (0)	0.00	-5.93 (3)	0.00	-6.09 (2)	0.00	0.32	0.10
ΔGFCF	-6.01* (0)	0.00	-5.95* (0)	0.00	-6.13* (3)	0.00	-6.07* (3)	0.00	0.13	0.11
ΔODA	-8.25* (1)	0.00	-8.21* (1)	0.00	-10.48* (9)	0.00	-10.36* (9)	0.00	0.08	0.09
ΔIMP	-4.35* (0)	0.00	-4.29* (0)	0.01	-4.34* (2)	0.00	-4.28* (2)	0.01	0.15	0.14
ΔEXCH	-4.63* (0)	0.00	-4.94* (0)	0.00	-4.70* (3)	0.00	-4.95* (3)	0.00	0.25	0.09

Source: Calculated by the author using Eviews13.

*Rejects null hypothesis at 1 percent level, **rejects null hypothesis at 5 percent level and *** rejects null hypothesis at 10 percent level. C stands for constant in the test equation and C,T stands for both constant and trend in the test equation. Selected lag lengths or bandwidth are in the parenthesis ().

KPSS test critical values: LM^{C} 1 percent= 0.74, 5 percent= 0.46, 10 percent= 0.35; LM^{C,T} 1 percent= 0.22, 5 percent= 0.15 and 10 percent= 0.12.

The results of unit root tests report that the series ANNI, GFCF, ODA, FDI, IMP and EXCH at level are non-statinary. The null hypothesis of unit root for the ADF and Philips Perron tests is accepted because the probabilities of test statistics are higher than 0.05 (Table-2). The null hypothesis of stationarity at level is rejected for the KPSS test because the LM-statistics are greater than the appropriate critical values. However, these time series at first difference are stationary because the probabilities of ADF and PP test statistics are lower than 0.05 (Table-2), and the LM-statistics for KPSS tests are lower than critical values. All the series under consideration are integrated of order one, I(1). Therefore, Johansen co-integration test seems inevitable (in case some of the series proofs to be I(0) and the others I(1), autoregressive distributed lag (ARDL) bounds testing approach holds good).

Co-integration: In order to apply Johansen test of co-integration, lag lengths (k) for the co-integrating equations was determined by Likelihood Ratio (LR) statistic, Final Prediction Error (FPE), AIC, Schwarz Information Criterion (SIC) and Hannan-Quinn (HQ) information criterion.

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Table-3: Lag Order Selection for Co-integration Test

Lag	LogL	LR	FPE	AIC	SIC	HQ
0	-23.47	N A	1.76e-07	1.47	1.73	1.57
1	227.94	414.83	3.78e-12	-9.30	-7.52*	-8.66
2	264.30	49.09	4.20e-12	-9.32	-6.02	-8.12
3	326.01	64.79*	1.65e-12*	-10.60*	-5.79	-8.86*

Source: Calculated by the author using Eviews 13.
*Indicates lag order selected by the criterion.

SIC selects lag length of one (Table-3). LR statistic, FPE, AIC and HQ information criteria select lag length of three. Since majority of the lag selection criteria (three out of four) selects lag length of three, Johansen co-integration test has been accomplished using lag order of two, where one lag is diminished for differencing (Lutkepohl, 2005). The series ANNI, GFCF, ODA, FDI, IMP and EXCH exhibit trends. Therefore, constants (no trend) have been included in the co-integrating equation and the short-run dynamics.

Table-4: Results of Johansen Co-integration Test

Unrestricted Co-integration Rank Test (Trace)				
No. of Co-integrated equations (Null Hypothesis)	Eigenvalue	Trace Statistic	Critical value (5 percent)	Probability
None*	0.76	166.41	95.75	0.00
At most 1*	0.65	108.59	69.82	0.00
At most 2*	0.51	66.39	47.86	0.00
At most 3*	0.48	38.08	29.79	0.00
At most 4	0.24	11.79	15.49	0.17
At most 5	0.02	0.65	3.84	0.42
Unrestricted Co-integration Rank Test (Maximum Eigenvalue)				
No. of Co-integrated equations (Null Hypothesis)	Eigenvalue	Max-Eigen Statistic	Critical value (5 percent)	Probability
None*	0.76	57.83	40.08	0.00
At most 1*	0.65	42.19	33.88	0.00
At most 2*	0.51	28.32	27.58	0.04
At most 3*	0.48	26.29	21.13	0.01
At most 4	0.24	11.14	14.26	0.15
At most 5	0.02	0.65	3.84	0.42

*Denotes rejection of the hypothesis at the 0.05 level

The trace statistics (Table-4) indicate that the null hypotheses of no co-integration, at most one co-integration, at most two co-integration and at most three co-integration are rejected because the statistics (166.41, 108.59, 66.39 and 38.08 respectively) are higher than the five per cent critical values (95.75, 69.82, 47.65 and 29.78 respectively) with corresponding probability 0.00 (less than 0.05). However, the null hypothesis of at most four co-integrating relation is accepted because the value of trace statistic (11.79) is lower than five per cent critical value (15.49) and corresponding probability is 0.17 (greater than 0.05).

Maximum eigen-value statistics for the null hypotheses of no co-integration, at most one co-integration, at most two co-integrations and at most three co-integration relationships (57.83, 42.19, 28.32 and 26.29 respectively) are higher than five per cent critical values (40.08, 33.88, 27.58 and 21.13 respectively) with corresponding probabilities less than 0.05. Maximum eigen statistic (11.14) for the null hypothesis of at most four co-integration relation is less than five the per cent critical value (14.26) and the corresponding probability (0.15) is greater than 0.05.

Hence, both trace statistics and eigen-value statistics affirm that there are four co-integrating relationships among FDI, ANNI, GFCF, ODA, IMP and EXCH series. Under the situation, estimation of vector error correction model is suitable.

Results of VEC Model: Vector error correction model presents both the short-run and long run dynamic relationships among the time series data for FDI, ANNI, GFCF, ODA, IMP and EXCH. Only short run dynamics has been recorded (Table-5) for the purpose of disposition.

Table-5: Vector Error Correction Estimates

Error Correction	ΔFDI	ΔANNI	ΔGFCF	ΔODA	ΔIMP	ΔEXCH
Cont. Eqn.	-0.56* [-4.10]	-0.01 [-0.37]	-0.03 [-1.25]	0.11 [1.45]	-0.08* [-2.69]	0.01 [0.23]
ΔFDI(-1)	0.21 [1.33]	0.04 [1.55]	0.06 [1.86]	-0.03 [-0.34]	0.03 [0.95]	-0.03 [-1.68]
ΔFDI(-2)	-0.30* [-2.09]	0.01 [0.23]	-0.01 [-0.01]	0.06 [0.72]	0.01 [0.25]	0.01 [0.18]
ΔANNI(-1)	13.94* [3.64]	1.45* [2.36]	2.19* [2.82]	-1.41 [-0.67]	2.36* [2.69]	-1.47* [-3.58]
ΔANNI(-2)	5.19 [1.68]	0.76 [1.53]	1.02 [1.62]	1.21 [0.71]	2.36* [2.25]	-0.31 [-0.93]
ΔGFCF(-1)	-7.58* [-3.40]	-0.44 [-1.22]	-0.79 [-1.74]	1.87 [1.51]	-0.65 [-1.28]	0.16 [0.68]
ΔGFCF(-2)	-2.64 [-1.11]	-0.06 [-0.15]	-0.07 [-0.14]	0.11 [0.09]	-0.74 [-1.35]	-0.19 [-0.78]
ΔODA(-1)	-0.01 [-3.04]	0.01 [0.26]	-0.02 [-0.23]	-0.25 [-1.35]	-0.07 [-0.88]	0.01 [0.09]
ΔODA(-2)	-0.36 [-1.16]	0.01 [0.08]	-0.04 [0.56]	-0.08 [-2.38]	-0.08 [-1.19]	0.02 [0.50]
ΔIMP(-1)	-1.25 [-0.95]	0.05 [0.25]	0.01 [0.04]	0.15 [0.20]	0.07 [0.25]	0.12 [0.86]
ΔIMP(-2)	2.81* [2.31]	-0.23 [-1.19]	-0.19 [-0.75]	0.07 [0.10]	-0.06 [-0.19]	0.09 [0.69]
ΔEXCH(-1)	1.03 [0.22]	1.44 [1.91]	1.59 [1.66]	2.18 [0.84]	1.35 [1.25]	-1.25 [-2.47]
ΔEXCH(-2)	0.01 [0.01]	-0.42 [-0.73]	-0.57 [-0.77]	1.88 [0.94]	-0.74 [-0.89]	0.14 [0.36]
R^2 -value	0.61	0.35	0.36	0.43	0.39	0.47
Adj.-R^2	0.41	0.02	0.04	0.14	0.08	0.21
Prob. (F-stat) =0.01, Durbin Watson= 2.07						

*Indicates statistically significant (t statistics in the brackets)

Table-5 exhibits that the coefficient of co-integration term is negative (-0.56) and statistically significant (t statistic -4.10). This implies that there are co-integration relations and short run equilibrium is deviated from the long run equilibrium. The speed of adjustment from short run equilibrium to long run equilibrium is 56 per cent annually.

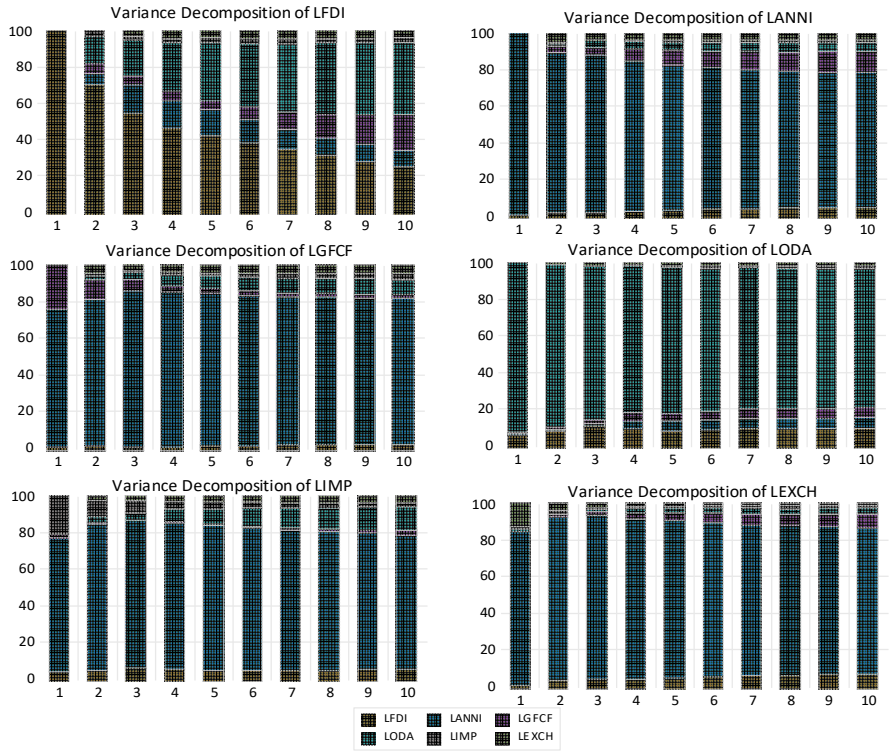
VEC Granger Causality (Block Exogeneity) Wald Test: Granger causality/Block exogeneity Wald tests, based on VEC model, has been carried out for the investigation of short run causal relations among FDI, ANNI, GFCF, ODA, IMP, and EXCH. Results with statistical significance (for which Chi-square statistics are very high and corresponding probabilities are less than 0.05) have been reported in Table-6.

Table-6: VEC Granger Causality (Block Exogeneity) Wald Test

Excluded	Chi-square	Df	Probability
Dependent Variable ΔFDI			
ΔANNI	13.62	2	0.00
ΔGFCF	11.57	2	0.00
Jointly	29.16	10	0.00
Dependent Variable ΔGFCF			
ΔANNI	8.57	2	0.01
Dependent variable ΔEXCH			
ΔANNI	12.86	2	0.00

Variance Decomposition: Forecast error variance decomposition of FDI, ANNI, GFCF, ODA, IMP, and EXCH shows the change in a time series due to its own shock as well as that of the other series. Results of variance decomposition (for the VEC model) for the period of ten years have been reported in Figure-3.

Figure-3: Variance Decomposition (using Cholesky ordering df. adjusted**).**



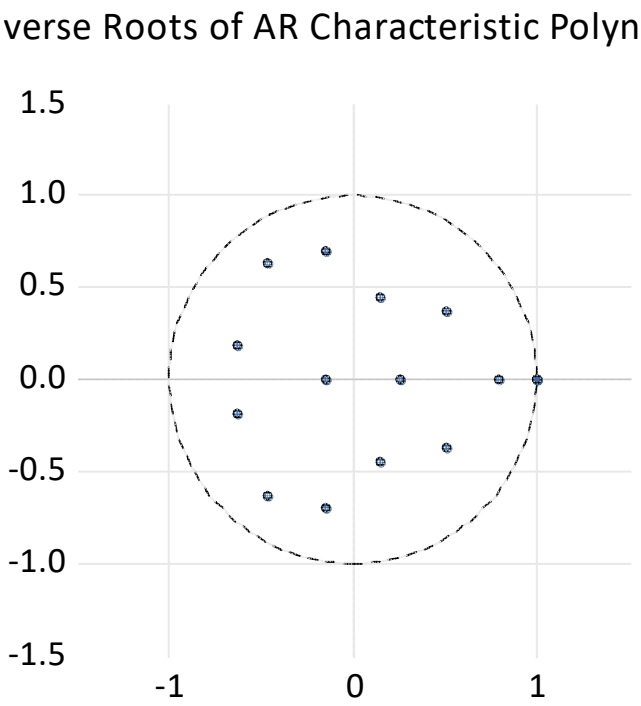
Source: Drawn by the author using Eviews 12

Model Stability Diagnostics: Residual based diagnostic tests have been pursued for testing stability of the model. Residuals of the co-integrating equation (equation of the focused variable ΔFDI) is normally distributed with Jarque-Bera statistic 0.36 and corresponding probability of 0.51. Breusch-Godfrey LM test shows that there is no serial correlation. Heteroscedasticity ARCH test vindicates that there is no heteroscedasticity in the residual because the null hypothesis of homoscedasticity is not rejected (the probability of F statistic is 0.69 and that of Chi-square statistic is 0.68, both more than 0.05).

Inverse roots of autoregressive characteristic polynomial show that all the roots lies inside the unit circle (Figure-4). Recursive stability diagnostic tests such as KUSUM test (Figure-5) and

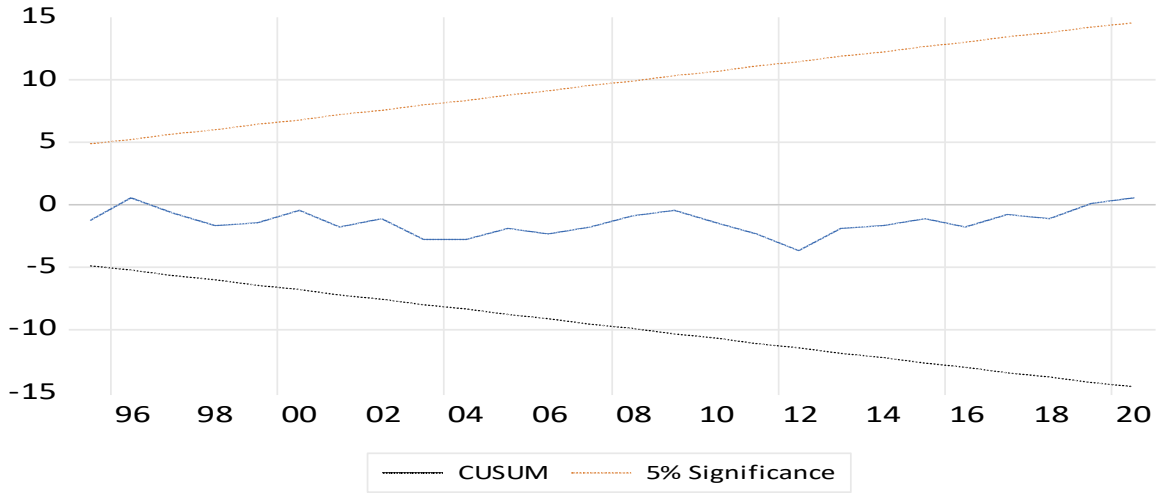
KUSUM-square tests (Figure-6) show that the model is stable because both the KUSUM and KUSUM-squared lie inside the 5 per cent confidence bounds. All these diagnostic tests point out that the estimated parameters of the model are stable (there is no structural break).

Figure-4: Unit Circle



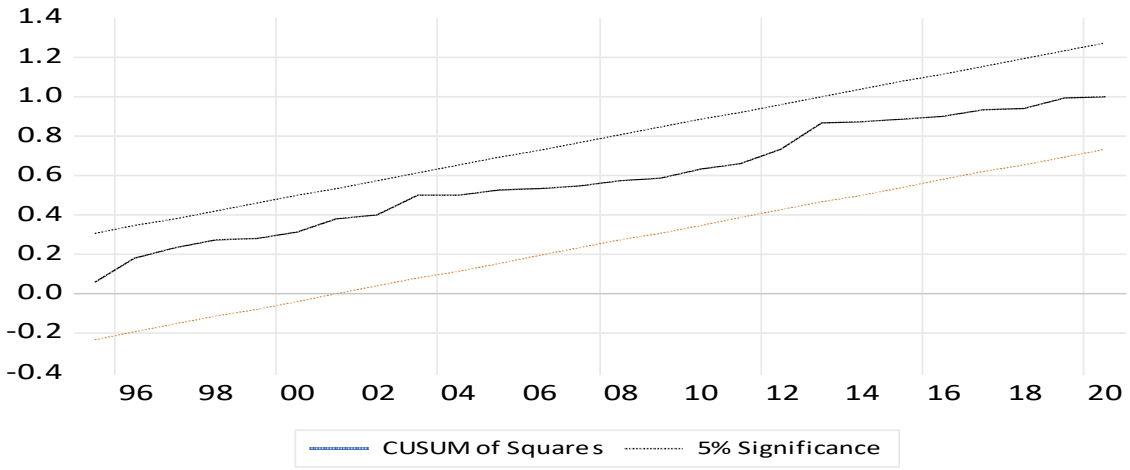
Source: Calculated by the author using Eviews 13

Figure-5: KUSUM Test



Source: Sketched by the author using Eviews 13

Figure-6: KUSUM-squared Test



Source: Sketched by the author using Eviews 13.

VI. Discussions of the Results

Short-run dynamics in the vector error correction model reveals that adjusted growth (ANNI) positively impacts foreign direct investment (FDI), gross fixed capital formation (GFCF) and imports of goods and services (IMP). A one unit increase in adjusted income growth raises foreign direct investment by 13.49 units in one year. One percent increase in sustained growth increases gross fixed capital formation by 2.19 percent in one period and the same quantity in two periods. Similarly, a one unit increase in adjusted growth increases imports by 2.36 units in both one year and two years periods. However, adjusted growth negatively affects changes in exchange rate. Gross fixed capital formations have negative impact on foreign direct investment. One dollar increase in gross fixed capital formation reduces foreign direct investment by 7.58 dollars. Bulk of gross fixed capital formation comes from domestic sources because share of foreign direct investment in India is only around two and half percent of GDP. Therefore, the role of foreign direct investment in India still remained passive in the growth process.

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Granger causality (Block exogeneity) Wald test shows that sustained growth and gross fixed capital formation individually causes foreign direct investment. Besides, adjusted growth, gross fixed capital formation, imports, official development assistance and spot exchange rate jointly causes foreign direct investment in India because Chi-square value is very high (29.16) and the probability of that value is less than 0.05 (0.00). Causality between income growth and change in exchange rate is bi-directional. Adjusted growth Granger causes gross fixed capital formation. Forecast error variance decomposition of the concerned series shows that the variance decomposition reinstates the results found from vector error correction and Granger causality Wald tests.

VII. Conclusion

This study is an approach to estimate co-integration and vector error correction models for exploring the links between sustained growth and some selected macroeconomic variables of Indian economy. This study differs from the existing studies in that the conventional methodology of those studies incorporated either macro-economic variables or macro-economic variables with one or a few environmental variables (Sabra, 2021; Latief et al. 2021; Doytch et al., 2024; Sharmiladevi, 2024). The holistic approach of this study is to investigate the relationship between macroeconomic variables considering overall environmental damage through the incorporation of environment-adjusted income in the model employed, instead of incorporating GDP or GNI. The study explored that long run equilibrium relationship (co-integration) prevails among foreign direct investment, adjusted growth, gross fixed capital formation, foreign aid, imports and exchange rate. Adjusted growth positively impact foreign direct investment, gross fixed capital formation and imports of goods and services. But, gross fixed capital formation negatively affects foreign direct investment in India. Adjusted growth affects and is affected by the change in exchange rates. Interestingly, in the short-run, sustained growth is not affected by foreign direct investment, gross fixed capital formation, foreign aid, imports and exchange rates. COVID-19 pandemic has hindered the performance of Indian economy in 2020, excepting the inflow of foreign direct investment. But the economy rebounded immediately by the following year. Despite the implementation of several FDI liberation policies, FDI-GDP share remained at a lower level. For India, official development assistance has no impact on sustained growth or capital formation of the economy. However, literature suggests that country specific official development assistance is effective for income growth or accelerating capital formation (Chenery and Strout, 1966; Ono and Sekiyama, 2024; Teng, 2021). Rigorous research studies are essential to explore whether the environmental variables have any impact on income and capital formation in this distinct impact of ODA. Over the study period, inflow of official development assistance gradually decreased in India, and the economy achieved self-reliance over time. For the entire study period, balance of trade was negative. However, balance of payments was favourable due to the inflow of foreign capital (capital account surplus). In a nutshell, investment and foreign trade policies of the country require special attention to protect its natural resources for the achievement of sustainable development.

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