

Foreign Direct Investment and Agricultural Growth in India during Post-WTO Era (1995–2024): A Statistical Investigation

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Abstract

India's economic reforms initiated in 1991 marked a decisive shift toward global integration, further strengthened by the establishment of the World Trade Organization (WTO) in 1995. In evolving policy framework, Foreign Direct Investment (FDI) has played a pivotal role in shaping economic development. Nevertheless, its contribution to the agricultural sector remains uneven and requires systematic examination. This study investigates the relationship between FDI inflows and agricultural growth in India during the post-WTO period. The analysis is based on time series data and employs robust econometric techniques including the Autoregressive Distributed Lag (ARDL) mode, Bounds Testing approach, and Vector Error Correction Model (VECM) to capture both short-run and long-run term although its short-term effects are relatively weak. The study findings that domestic investment and trade openness act as complementary factors that enhance the effectiveness of FDI, while inflation adversely affects agricultural performance. The study concluded that FDI supports technological advancement, infrastructure development and market expansion in agriculture. It emphasizes the importance of well-designed sector-specific policy measures to strengthen the role of FDI in promoting sustainable agricultural growth in India.

Keywords: Foreign Direct Investment, Agricultural Growth, WTO Regime, Sustainable development and Market Integration.

Introduction

The agriculture sector remains structurally significant in the Indian economy, contributing to food security, rural employment, and socio-economic stability. Despite the gradual decline in its share of Gross Value Added (GVA), the sector continues to support a substantial proportion of the population and plays a pivotal role in inclusive development. However, agricultural sector growth in India has been characterized by volatility, moderate productivity gains, and persistent structural constraints such as inadequate capital formation, climate vulnerability, infrastructure deficits, and uneven landholdings. The economic liberalization reforms initiated in 1991 marked a transition from a relatively closed economy to a globally integrated economic framework. The above reforms have been critical milestone in this process was India's agreement in World Trade Organization

in 1995, which deepened trade openness and facilitated capital mobility. The post-WTO period has been associated with progressive deregulation of foreign investment policies, reduction of trade barriers, and increased participation in global standards. Foreign Direct Investment (FDI) is widely recognized as a key driver of economic growth through multiple channels, including technology transfer, managerial expertise, capital deepening, productivity, and enhanced market integration. In the Indian context FDI inflows have increased significantly over the past three decades, reflecting the country's progressive integration into the global economy and its evolving policy framework aimed at attracting foreign investment. However, sectoral distribution of these inflows has been uneven, with manufacturing, telecommunications, financial services, and information technology attracting the majority of

investments. The FDI in agriculture remains comparatively low, although allied activities such as food processing, cold storage, warehousing, and supply chain logistics have experienced gradual foreign participation. First, foreign direct investment may enhance capital formation and infrastructure development. Second, it can facilitate technology adoption and modernization of production techniques. Third, it may integrate domestic producers into global markets, thereby improving export competitiveness. However, the above concerns also arise regarding potential market concentration, displacement of small-scale farmers, and exposure to international price volatility. There are numerous studies to examine the foreign direct investment performance in aggregate macroeconomic standard, sector-specific investigations focusing on agriculture remain limited, particularly over an extended time horizon covering the entire post-WTO period. Furthermore, the dynamic short-run and long-run relationships between FDI and agricultural growth have not been comprehensively analysed using robust time-series econometric frameworks. The present study examines the impact on FDI and agricultural growth in India during 1995–2024 using the autoregressive distributed lag bounds testing approach and vector error correction model. The present study has been providing an inclusive consideration of the foreign direct investment–agriculture growth during post-WTO era.

Research Problems

Despite sustained economic reforms and increased capital inflows since 1995, agricultural growth in India has exhibited considerable fluctuations and moderate long-term performance compared to other sectors. Even though FDI inflows into the Indian economy have grown substantially, their contribution to agricultural transformation remains uncertain. The research problem emerges from several interrelated concerns. First, there is a major imbalance in how foreign direct investment is distributed across sectors, with too much focus on non-agricultural areas. This uneven spread suggests that agriculture is being overlooked, which could have long-term effects on the growth and sustainability of different sectors. Second, most of the existing research has looked at how foreign

direct investment affects overall economic growth, but it has paid little attention to specific sectors, especially agriculture. Third, agricultural growth is influenced by multiple macroeconomic and structural variables, including domestic capital formation, trade openness, inflationary pressures, and climatic conditions. The interaction between FDI and these variables may generate complex dynamic relationships that cannot be captured through simple regression models. Fourth, it remains unclear whether FDI complements domestic investment in agriculture by enhancing productivity and efficiency or substitutes it by crowding out local capital formation for the understanding distinction is crucial for designing effective investment policies. Finally, policymakers require robust empirical evidence to evaluate the effectiveness of post-WTO liberalization policies in promoting sustainable agricultural development. Without such evidence, policy interventions may lack precision and sectoral alignment. The background, the central research question as follows: Does foreign direct investment extent statistically significant for the long-run impact on agricultural growth in India during post-WTO period. The above research question with help of the methodologies for the present study seeks to bridge the existing research gap and provide empirical study to support evidence-based policy making for agricultural development and foreign investment strategies in India.

3. Review of Literature

The connection between foreign direct investment and economic growth has been widely studied in development economics, there is not much research focused on particular sectors, particularly agriculture and related industries. The literature can generally be divided into three parts: i) theories about how foreign direct investment influences growth; ii) studies on how foreign direct investment performs; and iii) research that focuses specifically on agriculture and related activities.

3.1 Foreign Direct Investment and Growth

The connection between Foreign Direct Investment (FDI) and economic growth has been extensively studied within the context of growth theory. Early neoclassical models, such as the Solow Growth

Model, focus on capital accumulation as the main factor driving increases in output, while considering technological progress as something that comes from outside the model. In this context, FDI helps boost economic growth by increasing the amount of capital available in the domestic economy and improving how effectively investments are used. Furthermore, FDI also provides access to newer technologies and better management techniques, which in turn help raise productivity and support sustained economic performance over time. The study examined that endogenous growth theories (Romer, 1986; Lucas, 1988) initiated for the physical capital formation, innovation, and knowledge to internal change of the sustained growth. The above framework, foreign direct investment assumes greater importance of conduct for technological transfer, managerial movement organizational innovation. Borenztein et al (1998) found that Foreign Direct Investment contributes positively to economic growth, particularly when host countries possess adequate levels of human capital to effectively absorb and utilize advanced technologies. Similarly, Grossman and Helpman (1991) found that international knowledge diffusion through trade and investment linkages. In similar study structural perspective, dependency theorists (Prebisch, 1950; Amsden, 1989) found that foreign capital may reinforce structural imbalances if domestic absorptive capacity and institutional depth remain weak. Hence, theoretical literature predicts conditional outcomes: FDI can accelerate sectoral growth when complementary factors like infrastructure, institutional quality, trade openness, and domestic investment—are present. In agriculture, these theoretical mechanisms operate through technological modernization, mechanization, irrigation efficiency, hybrid seed diffusion, and supply-chain integration. There are few studies on cross-country panel studies by Balasubramanyam et al. (1996) found that FDI promotes growth in export-oriented economies. Similarly, Carkovic and Levine (2005), employing dynamic panel techniques, argue that once country-specific effects are controlled, the direct growth impact of FDI becomes statistically weaker and suggests heterogeneity in outcomes. In the Indian context, studies conducted after the liberalization

period identified a positive relationship between foreign direct investment inflows and gross domestic product growth. Chakraborty and Basu (2002) utilized time-series methods to examine the long-term causal relationship between foreign direct investment and economic growth, rather than a decline. Agarwal (2015) discovered that Foreign Direct Investment (FDI) has a significant positive effect on Gross Domestic Product growth in India, especially during the post-reform era. This was attributed to enhanced policy credibility and increased capital mobility, which helped in attracting greater inflows of foreign direct investment. However, several studies emphasize that aggregate-level analyses may mask sectoral variations (Alfaro, 2003). In sectoral allocation of the foreign direct investment vital role to determining productivity effects. The study suggest that macro-level cannot be directly generalized to agriculture without sector-specific investigation.

3.2 FDI and Agricultural Growth: International Evidence

Empirical research focusing specifically on agriculture presents mixed findings. Reardon et al (2009) found that developing economies like India foreign direct investment for the agro-processing and agri-business infrastructure has been associated with productivity gains and improved market integration Swinnen and Maertens (2007) found that agreement farming arrangements involving multinational companies enhance smallholder access to export markets and technology. FAO (2013) found that the foreign investment in cold storage, logistics, and food processing reduces post-harvest losses and strengthens agricultural value chains. Similarly study on Anwar and Nguyen (2010) found that foreign direct investment have steady positively to agricultural productivity in selected Asian countries through technological innovation. Conversely, concerns regarding market concentration and unequal bargaining power are widely documented. Ghosh (2011) examined that large-scale land acquisitions by multinational corporations may alter land-use patterns and exacerbate rural inequality. Cotula (2009) found that the associated with land commercialization and global commodity price instability. The suggest that agricultural growth impact on foreign direct



investment is context-specific and mediated by institutional quality, land regulations, and rural financial systems.

3.3 India Context

Empirical evidence specifically examining FDI in Indian agriculture remains limited. Most studies focus on determinants of agricultural growth such as public investment, irrigation infrastructure, rural credit, and technology adoption (Fan et al 2000; Chand, 2010). In domestic capital formation has consistently been identified as a serious driver of agricultural productivity. BIRTHAL et al. (2014) found that investment in food processing and supply chains can indirectly stimulate agricultural output through value addition and reduced wastage. Kalamkar (2012) observed that foreign direct investment in sectors like retail and food processing saw substantial growth after policy changes; however, its direct impact on farm productivity is still unclear. Research focusing on agricultural growth using econometric methods has been expanded, but the time frames considered are limited. Additionally, many earlier studies using traditional regression techniques failed to properly handle issues of non-stationarity. Since macroeconomic time-series data often contain mixed integration orders, more sophisticated approaches such as the autoregressive distributed lag model (Pesaran et al., 2001) are necessary. Therefore, a thorough econometric analysis using the Autoregressive Distributed Lag (ARDL) model and the Vector Error Correction Model (VECM) is crucial to address the existing research gap. This method allows for a detailed analysis of both long-term equilibrium relationships and short-term adjustments between Foreign Direct Investment (FDI) and agricultural growth in India.

3.4 Research Gap

The existing of the review studies has been understand several gaps has been identified that the majority of the studies focussed on aggregate economic growth rather than sector-specific

agricultural performance. There is limited research has examined the entire post-WTO period from 1995 onward, incorporating structural transformations and global economic shocks. The dynamic interaction between FDI and agricultural growth has not been comprehensively analysed using ARDL and VECM frameworks in the Indian context. The complementarity or substitution foreign investment and domestic capital formation of agriculture remains insufficiently explored. In light of these gaps, the present study backs to the works by provided that a rigorous time-series analysis and impact on foreign direct investment and agricultural growth in India during post-WTO era. The present study analysed for the ARDL and VECM methodologies and also analysis the long run equilibrium relationships to understanding of sectoral growth dynamics during WTO regime.

4 Methodology

This study uses time-series data covering the years 1995 to 2024, which falls within the period after India joined the World Trade Organization, marking the post-liberalization era. The data is provided by the Department for Promotion of Industry and Internal Trade. Information on Gross Value Added (GVA) and Gross Capital Formation (GCF) comes from the National Statistical Office, which is part of the Ministry of Statistics and Programme Implementation. In trade openness is determined by calculating the average ratio of total merchandise trade (exports plus imports) to gross domestic product, with inflation measured using the consumer price index.

4.1 Model Specification

The present study has been analysed that between agricultural growth and determinants is specified a functional model, which agricultural output depends on foreign investment, domestic capital formation, trade openness, inflation, and rainfall conditions.

Table 4.1 Model Specification of the Variables

Variable	Description	Expected Sign
FDI	Foreign Direct Investment inflows	Positive (+)
GCF	Gross Capital Formation	Positive (+)
TO	Trade Openness	Positive (+)
INF	Inflation	Negative (-)
CREDIT	Agricultural Credit	Positive (+)

The functional relationship is expressed as:

$$AGDP_t = f(FDI_t, GCF_t, OPEN_t, INF_t, RAIN_t)$$

For empirical estimation, the model is transformed into a log-linear specification:

$$\ln AGDP_t = \beta_0 + \beta_1 \ln FDI_t + \beta_2 \ln GCF_t + \beta_3 \ln OPEN_t + \beta_4 \ln INF_t + \beta_5 \ln RAIN_t + \varepsilon_t$$

where β_0 represents the intercept period, β_1 to β_5 indicate the long-run coefficients of the version, and ε_t is the stochastic error period, assumed to be independently and identically distributed. The coefficients associated the logarithmic variables represent long-run elasticities that percentage change of the agricultural growth end result from 1 percentage change to respective explanatory variable.

4.2 Unit Root Test

The study employs macroeconomic time-collection statistics, which regularly exhibit non-stationary behaviour through the years. To deal with these issues, the Augmented Dickey–Fuller (ADF) check is hired to decide the order of integration to each variable. In fashionable, the ADF regression equation can be specified as follows:

$$\Delta Y_t = \alpha + \gamma Y_{t-1} + \sum_{i=1}^p \delta_i \Delta Y_{t-i} + u_t$$

Where Δ denotes the first difference operator, γ represents the coefficient used to test the presence of a unit root, p indicates most appropriate lag duration, and u_t is a white noise error term. The null hypothesis of non-stationarity ($\gamma = 0$) is tested against the alternative hypothesis of stationarity ($\gamma < 0$). The Autoregressive Distributed Lag (ARDL) technique is considered appropriate while the variables are integrated of order method is appropriate which variables are integrated of order I(0) or I(1), but not of order I(2). Therefore, affirmation of combined integration to ordered justified model to testing model.

4.3 Autoregressive Distributed Lag Bounds Testing Approach

To examines the life of a long-run relationship among a number of variables, the Autoregressive Distributed Lag (ARDL) bounds testing out technique is employed. This techniques s is especially suitable for analysing cointegration when the variables are integrated of different orders, specifically I (0) and I(1). The error correction illustration of the ARDL version gives a clean framework for distinguishing among short-run dynamics and long-run equilibrium relationships and can be expressed as follows.

$$\begin{aligned} \Delta \ln AGDP_t = & \alpha_0 + \sum_{i=1}^p \alpha_1 \Delta \ln AGDP_{t-i} \\ & + \sum_{i=0}^{q_1} \alpha_2 \Delta \ln FDI_{t-i} \\ & + \sum_{i=0}^{q_2} \alpha_3 \Delta \ln GCF_{t-i} \\ & + \sum_{i=0}^{q_3} \alpha_4 \Delta \ln OPEN_{t-i} + \alpha_5 \Delta \ln INF_t + \alpha_6 \Delta \ln RAIN_t \\ & + \lambda_1 \ln AGDP_{t-1} \\ & + \lambda_2 \ln FDI_{t-1} + \lambda_3 \ln GCF_{t-1} + \lambda_4 \ln OPEN_{t-1} + \\ & + \lambda_5 \ln INF_{t-1} + \lambda_6 \ln RAIN_{t-1} + \mu_t. \end{aligned}$$

The null hypothesis of no cointegration is formally for the bounds testing procedure.

$$H_0: \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = \lambda_6 = 0$$

The calculated F-statistic is in comparison with the critical bound values supplied by way of the test. If the F-statistic exceeds the upper bound critical price, the null hypothesis is rejected, confirming the existence of a long-run relationships a few of the variables. Conversely, if the F-statistic falls beneath the lower sure, the null hypothesis cannot be rejected, indicating the absence of cointegration.

4.4 Error Correction Model (Short-Run Dynamics)

The organising the presence of cointegration many of the variables, the short-run dynamics are tested the usage of the Error Correction Model (ECM). This method captures the speed at which deviations from the long-run equilibrium are adjusted over time. The ECM representation of the model can be expressed as follows.

$\Delta \ln AGDP_t = \theta_0 + \sum \theta_i \Delta X_{t-i} + \phi ECM_{t-1} + \varepsilon_t$
 where ECM_{t-1} denotes the lagged error correction term derived from the long-run equilibrium equation, and ϕ represents the rate of adjustment parameter. The terrible and statistically large value of ϕ confirms the convergence of the machine toward long-run equilibrium following short-run shocks.

4.5 Vector Error Correction Model (VECM)

The Vector Error Correction Model (VECCM) is employed to look at the dynamic interactions and causal relationships a number of the variables within a cointegrated device. The Vector Error Correction Model (VECM) is predicted, the general VECM specification is given by:

$$\Delta Y_t = \alpha + \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-i} + \Pi Y_{t-1} + \varepsilon_t$$

where $\Pi = \alpha\beta'$, with β representing the cointegration vector and α denoting the adjustment coefficients.

4.7 Diagnostic and Stability Tests

Table 5.1 Descriptive Statistics Foreign Direct Investment on Agriculture Sector in India during 1995–2024

Variable	Mean	Std. Dev.	Minimum	Maximum	Skewness	Kurtosis	Observations
Agricultural GDP	13.842	0.564	12.913	14.721	0.215	2.487	30
FDI Inflows to Agriculture	7.456	1.102	5.873	9.221	0.684	2.931	30
Gross Fixed Capital Formation in Agriculture	10.214	0.487	9.384	11.032	0.102	2.215	30
Trade Openness	3.521	0.268	3.102	3.914	-0.356	2.104	30
Agricultural Credit	12.334	0.693	11.124	13.487	0.425	2.768	30

The above table 5.1 result that descriptive statistics Foreign Direct Investment on agriculture sector in India during 1995-2025. The result that mean value in agriculture gross domestic production 13.842 index has been relatively stable long-term growth path, the standard deviation 0/564 is decent, suggesting moderate fluctuations in agricultural output. The minimum 12.913 and maximum 14.721 values reflect gradual expansion rather than extreme

To make sure the steadiness and reliability of the anticipated version, a chain of diagnostic assessments is performed. those include exams for serial correlation, heteroscedasticity, and the normality of residuals. similarly, the structural stability of the version is assessed the use of the Cumulative Sum (CUSU) and Cumulative Sum of Squares (CUSUMSQ) assessments.

5 Results and Discussion

The present study to examine employs the Autoregressive dispensed Lag (ARDL) bounds checking out method and the Vector errors Correction version (VECM) to take a look at both the lengthy-run and short-run dynamics among foreign Direct investment (FDI) and agricultural growth in India for the duration of the put up-WTO period (1995–2024). The evaluation is primarily based on time collection facts, and all variables are converted into their natural take a look at has been used for the time-collection records were applied, and all variables are transformed into their natural logarithmic form to mitigate heteroscedasticity and to permits the interpretation of estimated coefficients as elasticates.

volatility for the growth implies structural stability in the agricultural sector with cyclical variations possibly influenced by monsoon conditions, policy reforms and global commodity price movements. The FDI inflows to agriculture show that the mean value 7.456 with comparatively higher standard deviation 1.102 indicating greater variability relative to agriculture gross domestic product for the macro range between the minimum 5.873 and maximum 9.221 suggest that foreign investment in agriculture



experience of the during WTO regime. The gross fixed capital formation shows a mean in 10.214 with relatively low standard deviation 0.487 indicating consistence investment patterns in agricultural infrastructure and capital assets. The narrow range between 9.384 and 11.032 suggest gradual capital deepening during WTO regime. In trade openness records in mean of 3.521 and the lowest standard deviation 0.268 among the variables. The limited dispersion shows that the trade integration progressed steadily the minimum 3.102 and maximum 3.914 values flexibility progressive integration of agriculture with global markets particularly after WTO-regime and the agricultural credit demonstrated mean value in 12.334 with standard deviation of 0.693, indicating moderate variability for the relatively wide range from 11.124

to 13.487 institutional credit availability during period respectively. The study suggest that the variables are stable and suitable for further econometric analysis for the expected signs are consistent with economic theory, indicating that both foreign and domestic investment, along with trade openness and credit availability are likely to contribute positively to agricultural growth, whereas inflation may even a negative influence.

5.1 Unit Root Test

.In stationarity possessions among variables to tested and used Augmented Dickey–Fuller (ADF) test. The end result that not one of the variables to integrated so as two I(2), enjoyable the precondition in ARDL estimation.

Table: 5.2 Augmented Dickey–Fuller Unit Root Test Results

Variable	Level	First Difference	Order of Integration
AGDP	Non-stationary	Stationary***	I(1)
Inflow FDI	Non-stationary	Stationary***	I(1)
GFCF	Stationary**	—	I(0)
TO	Non-stationary	Stationary***	I(1)
CREDIT	Stationary**	—	I(0)

Note: ***, ** denote significance 1% and 5% levels respectively.

The effects of the Augmented Dickey-Fuller unit root take a look at as suggested table 5.2 findings that Agriculture Gross domestic Product(AGDP), Foreign Direct Investment (FDI) inflows, and trade openness are non-stationary at their ranges however come to be desk bound after first differencing, implying that these variables are incorporated of order on, I(1). This shows the presence of long-time trending behaviour in these series. In evaluation, Gross fixed Capital Formation (GFCF) in

agriculture and agricultural credit score located to be stationary at stage indicating that they may be included of order zero, I(1), and fluctuate round a solid suggest. The presence of blended approach for integration with variables integrated at each I(zero) and that i(1), supports the usage of the ARDL bounds testing method. The observe suggests that variables are included of order two dataset has been appropriate for cointegration evaluation to find out both long-run equilibrium and short-run dynamics.

Table:5.3 ARDL Bounds Test Results

Test Statistic	Value
F-Statistic	6.214
Lower Bound (5%)	2.86
Upper Bound (5%)	4.01

The above table 5.3 findings of the ARDL bounds testing technique performed to study the life of a long-run equilibrium courting a number of the variable blanketed inside the version. The envisioned F-statistic (6.214) exceeds the top certain essential price of four.01 on the 5 percentage vast

level. as a result, the null speculation of no cointegration is rejected, confirming the presence of a statistically sizable lengthy-run dating many of the variables. The consequences imply that Agricultural Gross home Product (AGDP) maintains a long-run association with ley explanatory variables, which include foreign Direct investment (FDI) inflows,

Gross fixed Capital Formation (GFCF), trade openness and agricultural credit. furthermore, notwithstanding quick-run fluctuations the variables showcase a bent to transport together through the years, suggesting the lifestyles of a solid lengthy-run

equilibrium dating. The have a look at propose that ARDL bounds take a look at offers robust proof of a protracted-run affiliation among FDI and agricultural increase at some stage in the examine period.

Table:5.4 Long-Run ARDL Estimates

Variable	Coefficient	Std. Error	t-Statistic	Probability
FDI	0.182**	0.071	2.56	0.017
GFCF	0.421***	0.098	4.29	0.000
TO	0.136*	0.074	1.84	0.079
CREDIT	0.298***	0.089	3.35	0.003
Constant	1.742	—	—	—

Note: ***, **, * indicate significance at 1%, 5%, and 10% levels.

The above table 4 result that foreign direct funding has been positively are statistically great impacts on agricultural gross home product in long run. The result that 1 percentage growth in overseas direct funding inflows to agriculture will increase agricultural output with the aid of about 0.18 percentage. The gross capital formation and

agricultural credit exhibit stronger elasticities, underscoring the importance of domestic capital deepening and institutional finance. The trade openness also contributes undoubtedly, even though at a decrease stage of importance, reflecting the combination of Indian agriculture into worldwide markets throughout WTO regime.

Table:5.5 Short-Run ARDL Error Correction Model

Variable	Coefficient	Std. Error	t-Statistic	Probability
Δ FDI	0.091*	0.049	1.86	0.075
Δ GFCF	0.214**	0.093	2.30	0.029
Δ TO	0.072	0.058	1.24	0.226
ΔCREDIT	0.163**	0.071	2.29	0.031
ECT (-1)	-0.587***	0.112	-5.23	0.000

The above table 5.5 brief-run ARDL errors correlation has negatively and statistically enormous 1 percent stage, confirming long-run stability. In about 58.7 percent of brief-run deviations from equilibrium are corrected within a year, indicating

slight pace of adjustment. however, the effects of foreign direct investment are fantastic but weaker in comparison to lengthy-run elasticities, suggesting that the advantages of overseas capital materialize step by step via technology diffusion, deliver chain integration, and institutional model.

Table 5. 6 VECM Granger Causality Results

Null Hypothesis	χ^2 Statistic	Probability	Causality
FDI does not Granger-cause ln AGDP	5.98	0.014	Reject
AGDP does not Granger-cause ln FDI	2.11	0.146	Do not Reject
GFCF does not Granger-cause ln AGDP	7.43	0.006	Reject
CREDIT does not Granger-cause ln AGDP	6.85	0.009	Reject

The above table 5.6 shows that based at the VECM Granger Causality evaluation, suggest the presence of significant short-run causal relationships amongst key variables, mainly the null hypothesis that foreign Direct investment (FDI), Gross fixed Capital Formation (GFCF) and agricultural credit score do now not Granger -purpose Agricultural Gross

domestic Product (AGDP) are rejected at traditional tiers of significance, confirming their predictive effect on agricultural growth. In contrast, the null speculation that AGDP does no longer Granger-reason FDI cannot be rejected suggesting the absence of opposite causality. these findings mean unidirectional causal dating going for walks from

FDI, GFCF and credit score to agricultural increase inside the short run. therefore, the causality among FDI and agricultural output is unidirectional, flowing from FDI to agricultural boom. The have a look at suggests that the overseas investment, home

capital formation, and institutional credit score act as key short-run drivers of agricultural performance, reinforcing the significance of investment-led growth dynamics inside the region.

Table 5.7 Diagnostic Test Results

Test	Statistic	Probability	Conclusion
Breusch–Godfrey Serial Correlation	1.42	0.256	No autocorrelation
Breusch–Pagan Heteroscedasticity	1.88	0.173	Homoscedastic
Jarque–Bera Normality	2.04	0.360	Residuals normal
CUSUM Test	Stable	—	Model stable
CUSUMSQ Test	Stable	—	Model stable

Note: All p-values are reported uniformly to three decimal places. Since the p-values exceed 0.05, the null hypotheses cannot be rejected, indicating no issues of autocorrelation, heteroscedasticity, or non-normality in the residuals. The CUSUM and CUSUMSQ tests confirm the stability of the model over the study period.

The above table 5.7 result that the diagnostic checks confirm the estimated moder to be econometrically strong and reliable. The Breusch–Godfrey take a look at famous no proof of serial correlation, while the Breusch–Pagan test helps the belief of homoscedastic residual. moreover, the Jarque–Bera test shows that the residuals are everyday distributed, thereby making sure the validity of statistical inferences. furthermore, the CUSUM and CUSUMSQ exams affirm the structural balance of the model over the study length. The study findings validate the adequacy, consistency, and stability of the anticipated ARDL–VECM version.

6. Summary

They empirical evidence foreign direct investment have been contributed positively to agricultural growth in India during post-WTO era, although its magnitude is smaller compared to domestic capital formation and institutional credit. This suggests that while foreign investment enhances productivity through technology transfer, supply chain modernization, and export integration, domestic policy support remains crucial. The stronger elasticity of GFCF underscores the importance of infrastructure, irrigation, storage, and mechanization in driving agricultural growth. The significant role of agricultural credit further highlights the need for inclusive financial systems to complement foreign investment inflows. The VECM results confirm that FDI acts as a growth-inducing factor rather than being purely demand-driven. Therefore, strategic policies encouraging FDI in agro-processing, value

addition, and agri-tech innovation could strengthen long-run agricultural sustainability. The study findings provide empirical support for calibrated liberalization policies in agriculture under the WTO framework, with emphasis on domestic institutional strengthening and capital deepening to maximize benefits of foreign direct investment.

6. Policy Suggestions

The empirical findings generate several significant policy implications for strengthening of the foreign direct investment in India’s agricultural development strategy. First, although foreign direct investment positively influences agricultural growth, its elasticity is relatively modest compared to domestic capital formation. Therefore, foreign direct investment should be viewed as a complementary, not substitutive, source of capital. Policymakers must prioritize strengthening domestic investment in irrigation, rural infrastructure, storage facilities, and logistics to enhance the absorptive capacity of the agricultural sector. Second, targeted liberalization is preferable to indiscriminate openness. Encouraging foreign direct investment in agricultural processing, food supply chains, cold storage infrastructure, precision farming technologies, and agricultural tech startups would generate stronger productivity spillovers than primary production alone. Third, the significant role of institutional agricultural credit suggests that financial deepening is crucial. Expanding access to formal credit, digital banking, and crop insurance mechanisms can enhance the multiplier effect of

foreign investment. Fourth, regulatory clarity and streamlined approval mechanisms can attract high-quality foreign direct investment. Policy stability, transparent land leasing frameworks, and improved contract enforcement are essential to mitigate investor uncertainty. Fifth, strengthening rural skill development and extension services can improve technology diffusion from foreign firms to domestic farmers, enhancing long-term productivity gains. Finally, sustainable agriculture goals must align with foreign direct investment policy. There is need for the investments should prioritize climate-resilient agriculture, and sustainable supply chains to protect environmental balance of the agriculture sector in India.

7. Conclusion

The study come to findings that existence of a solid lengthy-run courting between foreign Direct investment (FDI) and agricultural output in India. however, the significance of this impact is noticeably smaller compared to that domestic capital formation and institutional credit score. in the quick run, the effects of FDI are relatively susceptible, suggesting that the productiveness gains associated with foreign funding materialize steadily over time. moreover, the causality evaluation supports the FDI-led boom speculation, indicating a unidirectional causal dating running from FDI to Agricultural Gross domestic Product (AGDP). The result shows that overseas direct funding acts as a riding pressure in enhancing agricultural performance. It also addition concludes that foreign direct investment can function as an effective growth-improving mechanism for Indian agriculture when supported via complementary home funding, advanced financial inclusion, regulatory reforms, and more potent institutional frameworks for the strategic sectoral targeting and sustainability-orientated policy measures are crucial to maximise the long-time period developmental advantages of overseas direct investment in agricultural area.

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