

## **Analyzing the Causal Nexus between Agricultural Production and FDI in Agricultural Sector of India**

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### **Abstract**

The inspiration behind this empirical study comes from the scant literature of FDI in agricultural sector. Agriculture considered being one of the prominent sectors of Indian Economy. During the times of pandemic, this is only sector that is resilient from crisis and shown 3.2% growth in terms of Gross Value Added. Henceforth it is imperative to understand the productivity of agricultural sector. FDI has been considered as the catalyst for the economy that provides technology, capital and demand. The paper studies the impact of FDI in agricultural sector of India. The causal nexus among FDI in agricultural sector and agricultural productivity has been studied and establishes the lead lag structure among them. The study has considered from 1991 to 2020 and applied wide variety of models ranging from Augmented Dickey Fuller Test, Ordinary Least Squares and Granger Causality. The results shown a unidirectional relationship and causality flows from FDI in agricultural sector to agricultural productivity. Finally, FDI in agricultural sector has been considered as a significant variable to predict agricultural productivity.

**Keywords:** FDI, Agricultural sector, Causal Nexus, OLS, Granger causality test

### **Background and Motivation**

Indian economy as a developing economy considered as an agricultural dominant. Agricultural sector helps to trigger employment, demand and growth. During the times the pandemic the evidences shown that the sector is resilient from the effect of the crisis. During this period the sector has reported the growth in GVA of 3.2%. This shown that the sector is having inelastic demand during the period recession. On the other hand FDI is considered as catalyst to trigger economic growth by infusing technology, capital and demand. The theoretical background of the study is to understand that how FDI done in agricultural sector is a significant determinant of agricultural production in India agricultural sector in India. The research establishes the causal nexus or leads and lag relation among FDI in agricultural sector and agricultural production.

There are plenty of studies that analysed the impact of FDI in India. According to Kaur et al. (2013) there is an interrelation between FDI and economic growth and that result in the growth of the country. Venkatachalam (2000) has identified the determinants and analysed them for FDI evaluation in India. Anantaram (2004) discussed the wide variables in sustainability factors and used the variables on economic, social and political factors that can leads to the indicator for the growth. Dua et al. (2015) examined the macroeconomic factors underlying FDI flows to India

using cointegrating VAR with I(1) exogenous variables. Mohanty et al. (2015) analysed the impact of FDI on Indian Economy. The study recognized that FDI is crucial pillar in all economies in general and developing economies in particular to provide managerial skills, infusion of technology, funds and employment. The study done by Rhodes, 2011 that FDI norms have been discussed the relaxation to the seed production to farm sector in India. Basu et al. (2017) analysed that FDI inflow in India is extremely skewed across the major sectors of the economy. Punthakey (2020) explored his study on FDI in the agriculture and food sectors, using a novel database of mergers and acquisitions (M&As).

The motivation to establishing the relation among two is based on the scant literature available of FDI in agricultural sector. Moreover the sector plays a crucial role in the growth of economy and lastly the FDI considered as robust determinant to accentuate growth of sectors.

The study establishes the causal relation among agricultural production and FDI, for this Granger Causality is the best suited model. Granger causality is the most popular method to identify causality whether unidirectional, bidirectional and none. Granger Causality is the prominent method to study the causal linkage between variables (Granger, 2001). The model has been applied when series are stationary at level I (0). Otherwise the variables that are non-stationary, once converted into stationary and the causal relation has been identified.

The results of the research study, signifies that the variables are stationary at level. Henceforth, the initial model in time series analysis, when the variables are integrated at level I (0), then Ordinary Least Squares (OLS) has been applied. The result of OLS has shown that FDI in agricultural sector has shown significant positive growth in agricultural production. The results are important for policy makers and regulators, to further relax the limit of FDI in various activities in agricultural sector. Further, the robustness of the model has been checked by diagnostic tests. To understand the causal nexus among the variables undertaken and to establish lead and lag structure among them, Granger causality test has been applied and results shown that FDI in Agricultural Sector is the Granger cause of Agricultural Production and the causality is unidirectional. Henceforth, FDI in agricultural sector is leading to Agricultural production. The results provide substantial insights to policy makers.

## **Research Methodology**

### **I. Objective of the Study**

- 1.** To understand the FDI in agricultural sector as a significant determinant of agricultural productivity
- 2.** To establish a causal nexus among FDI in agricultural sector and agricultural productivity in India.

### **II. Data Profile**

The study has considered the interrelation between FDI in agricultural sector on Agricultural production in India. The data has been taken annually from 1991 to 2020. The data of FDI in agricultural sector and agricultural production have been taken from Indiastats.

### **III. Methods and Models**

The study has considered a wide variety of models Augmented Dickey Fuller Test, Ordinary Least Squares and Granger Causality Test.

## Empirical Results

### Results of Stationarity

The result of stationarity has been captured in Table 5.1. Stationarity of the series means that mean, variance and covariance are time invariant and thus, remains constant. For the stationarity test Augmented Dickey Fuller (ADF) test has been applied. The result of the Augmented Dickey Fuller (ADF) test has shown that the two variables that are Agricultural production and FDI both are not stationary on its own. Henceforth, log values have been considered for further analysis. Generally, log values moderates the variations with in the series and thus makes series less volatile. Then the ADF test has been applied on log values of the variables and then the log values of FDI in agricultural sector and Agricultural production are stationary at level I (0). The coefficient of ADF test is negative and significant at the 0.05 significance level (see. Table 1).As the significance value is less than 0.05 that rejects the null hypothesis, that claims that the series are non-stationary and there is presence of unit root. Rejection of null hypothesis represents that there is no presence of unit root in the data and thus, it provides the evidences that the data is not following trend into it and therefore the mean, variance and covariance are stable at level.

**Table 1 Results of ADF Test**

Variables	Coefficient	p-value	Stationary
Agri_Prod	-2.1107	0.5302	
Ln_AgriProd	-5.3278	0.01	I(0)
FDI	-1.3619	0.8155	
Ln_FDI	-3.5791	0.0529	I(0)

### Results of Granger Causality

Before developing the OLS model, the study captures the causal nexus among agricultural production and FDI. The results of Granger causality provides the lead and lag structure among the variables considered in study. This facilitates in developing the model further. The results of stationarity has shown that the variables are stationary at level I (0), then we can apply Causality test. The table 2 shows the results of causality flow among these two. The results shows that the causality flows from FDI in agricultural sector to agricultural yield, as the p-value is 0.03 (lesser than 0.05), significant at the 0.05 significance level. The significant p-value rejects the null hypothesis that there is no causality and accepts the alternate, that there is a presence of causality. FDI in agricultural sector is the granger cause of Agricultural production. The causal movement is sound with theoretical background that the foreign flow of funds in agricultural sector improves the agricultural productivity. The results are crucial for policy makers.

On the other hand, the causal flow from agricultural production to FDI is not significant thus it is inferred that the agricultural production is not the causal factor to determine FDI. The inference drawn from Granger Causality is in consensus with the theoretical background. Thus, the causality is unidirectional and finally, it can be concluded that FDI in Agricultural sector is the granger cause of Agricultural productivity but Agricultural productivity is not a granger cause of FDI in Agricultural sector. This inference provides the base to formulate the lead and lag relation among two variables and to furnish suitable regression model. Henceforth, the FDI in agricultural sector is the leading to Agricultural production. At this, stage causality has been checked, but for establishing statistical significant relation among these two time series variables, OLS model has been developed.

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**Table 2: Results of Granger Causality**

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Granger Causality

grangertest(Agri\_Prod~FDI,order=2)

Granger causality test

2 14 -2 4.3641 0.03765 \*

grangertest(FDI~Agri\_Prod,order=2)

Granger causality test

**Model 1:**  $FDI \sim \text{Lags}(FDI, 1:2) + \text{Lags}(\text{Agri\_Prod}, 1:2)$

**Model 2:**  $FDI \sim \text{Lags}(FDI, 1:2)$

Res.DfDf F Pr(>F)

1 12

2 14 -2 0.1016 0.9041

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**Results of Regression Model**

The objective of the study is to identify the FDI as a determinant of the change in the yield of agriculture. The regression analysis has been formulated to identify the degree of association and magnitude of change among agricultural production and FDI. The results of Granger causality provide the insight to prepare the model of regression. The agricultural production has been considered as dependent or endogenous variable and FDI in Agricultural sector is considered as independent or exogenous variable.

The various assumptions of regressions that are: Stationarity of the variables by the application of Random Walk Model with special reference to Augmented Dickey Fuller Test (ADF-Test) ; mean variance of residuals are zero, there is no heteroskedasticity and autocorrelation of error term. For the presence of homoskedasticity and no autocorrelation has been checked from Breusch-Pagan test (BP-Test) and Durbin-Watson test (DW- Test).

The result of regression has been encapsulated in table 3 and diagnostic tests results in table 4. The result of Ordinary Least Square (OLS) shows that the model is fit at 0.05 significance level, as the overall p-value of the model is 0.003712, which is less than 0.05. The explanatory power of the model i.e. R<sup>2</sup> is 39.91%, it means the model explains approx. 40% of the change in

agricultural yield. Furthermore, it has been inferred that the log FDI is significant determinant to explain the change in agricultural production, as the p value is 0.00371, which is less than 0.05 (significant at the 0.05 significance level).

### Table3 Results of Regression (OLS)

Model\_Reg4=lm(lnAgri~lnFDI)

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-9.0151	6.5862	-1.369	0.18888
lnFDI	1.8875	0.5617	3.361	0.00371 **

Multiple R-squared: 0.3991, Adjusted R-squared: 0.3638

F-statistic: 11.29 on 1 and 17 DF, p-value: 0.003712

### Results of Diagnostic Tests

The robustness of the model has been checked by diagnostic tests (see. Table 5.4). The results of diagnostic test in lines with OLS properties that are Best Linear Unbiased Estimator (BLUE). The result shows that the errors are as close to zero and they are normally distributed. The results of Breusch-Pagan test, shown that the variance of error is homoscedastic and there is no autocorrelation. Henceforth the diagnostic tests shown that the results of the model are robust and the parameters drawn from the model could be used for future forecasting of Agricultural production with a unit change in FDI in agricultural sector. The results are in consensus with theory and the studies done on FDI in India and its impact on growth on economy. The results are crucial for policy makers and regulators.

### Table 4 Results of Diagnostic Test

1. The mean value of error term is as close to zero  $\text{mean}(\text{resi\_modelreg4})[1]$  0.0000000000000002220446
2. The distribution of residuals are normal JarqueBera Test X-squared = 0.80398, df = 2, p-value = 0.669
3. The variance of error term is homoscedastic Breusch-Pagan test BP = 6.9152, df = 1, p-value = 0.008547
4. Presence of Auto correlation Durbin-Watson test DW = 0.56206, p-value = 0.00003482

### Conclusion

The study analysed the impact of FDI in Agricultural sector on Agricultural productivity. The study has been done in rational way, firstly causal nexus or lead and lag structure has been established by the application of Granger Causality Test and then regression model has been developed based on the inferences drawn from Granger Causality.

The study has applied OLS, hence it is imperative to check the presence of unit root or trend in the time series. The study has taken the log values of the variables and then Augmented Dickey Fuller Test has been applied and the results shown that the variables are stationary at level I (0). The level of stationary provides the background for the application of regression.

The results of Granger causality shown that the causality is unidirectional and the causality moves from FDI in agricultural sector to Agricultural productivity. The results provide the basis for the formulation of regression model.

Finally, on the basis of the evidences drawn from Granger Causality, the Agricultural productivity has been considered as endogenous variable and FDI in Agricultural sector considered as exogenous variable. The result of regression strengthens the theoretical postulation of the study and provides statistically significant evidence that FDI in agricultural sector improves the productivity/ yield of Agricultural sector. The results and the evidences drawn from the analysis, provides substantial background to understand the importance of FDI in agricultural sector. The insights drawn from the study is important to policy makers and regulators.

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