



Agriculture, Manufacturing and Economic Growth in India: A Co-integration Analysis

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ABSTRACT

This study examine the most debatable question of the last three decade, i.e., "Does the agriculture growth affect the economic growth?" with the use of annually data from 1966-to 2016. The study employed unit root and causality test suggested by the Dicky fuller, Phillips-Perron and Granger respectively. Besides, ARDL techniques used to analysis the relationship among the variables, i.e., agriculture, manufacturing and economic growth for the short as well as long period of time. As per outcome, result shows that, uni-directional causality running from manufacturing and economic growth to agricultural growth. Moreover, unidirectional causality running from economic growth to manufacturing growth. Results also showed that bidirectional causal relationship between economic and agriculture growth. It can be concluded that, this study support of a very famous statement "agriculture is the engine of economic growth" this statement is valid for the short period of time but manufacturing contributed more than agriculture sector to the economic growth in the long run in India.

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1. Introduction

This study examines the most debatable and confusing issue "Does the agriculture sector matters in the economic growth in the case of India." Gardner raised the question on the causal relationship between two most important variables of the economy i.e. agriculture and economic growth in his "Elmhirst" lecture in 2003. Gardner (2005) proved that there is a significant positive relationship between agriculture and economic growth. However the main question on the directional causality among the variables need to be discussed. His conclusion was that "an investigation of lags...

does not show agriculture as the leading sector." Many studies contradict each other to answer this question which as mentioned above. Some of the scholars argue that transfer of the excess resources (Labors) from agriculture sector always leads to the agriculture driving economic growth and development. While other scholars believe that increasing wages in the non-agriculture sector leads to the increases productivity of agriculture. Thereby implies that one-way causality was running from economic growth to agriculture growth (Lewis, 1954). Some well-known developmental economist emphasized on the non-agriculture sector (Industrial sector) and explain industrial sector is the foundation of development of the economy, and they biased against of agriculture sector (Schiff, Valdés, & Bank, 1998). But in the 1970s, which low-income countries challenged this view and explain the necessity of agriculture development became part of the conventional wisdom (World Bank, 1982). The classical economist Clark (1940) and Kuznet (1960) clarify the essential facts concerning the agriculture sector in economic growth and development. Lewis (1954) emphasized on the double sector economy on the basis of abundant labor in the agriculture sector and thus transfer from farming to industrial development. Hardly, after few years, Ranis and Fei (1961) extended the two-sector model which had been adopted by numerous scholars (Matsuyama 1992; Steger 2000; Vollrath 2009). While another scholar Humphries and Knowles (2010) argues that transfer of labor is directly associated with the economy (Economic growth) of the nation.

Most of the classical economist thought that agriculture sector plays utmost role through production and consumption linkages in the economic growth. Johnston & Mellor, (1961) explain agriculture sector contributes mainly through five interlinkages in the economy for the developing nations, which are transfer of excess labor to the non-agriculture sector, providing the foods for the domestics consumption, provision of market for industrial production, savings uses for the investment in the non-agriculture sector; and use of earnings obtained from agriculture export to the finance the import of goods. Apart from, singer (1979) emphasized on agriculture demand led industrialization (ADLI). Adelman, et al. (1984) proposes that the ADLI appropriate for middle-income nations which are not yet export driven. Notwithstanding, Gollin, (2009) thinks about that extensive offer of agriculture sector in developing countries does not straightforwardly suggest that economic development must be founded on an ADLI-type. The recently hypothetical and pragmatic research on this subject shows the intensity of debate has been increased (Gardner, 2005; Gemmell, Lloyd, & Mathew, 2000; Tiffin and Irz, 2006). Research on this subject is essential because it supports to formulate the appropriate policy (domestic and international) in favor of decision making regarding the allocation of limited resources to different sectors of the economy (especially agriculture and non-agriculture sector). The main purpose of this article is to find out the answer of the most debatable and confusing question "Does the agriculture growth matter in economic growth in the developing countries"? We examine short and long-run causality relationship among the variables, i.e., agriculture, manufacturing and economic growth. This research article divided into five distinct sections; first part deal with the introduction and underlying problems of study and the second part explains the previous literature which illustrates different views of the researchers regarding this question. Third section deal with data, methodology and analysis and the fourth section primarily deals with empirical results and discussions and finally, the fifth section explains the conclusion and policy implication based on major studied variables.

2. Previous Studies

Previous studies show the confusing result and remain a dearth of unanimity on the role of the agriculture sector in economic growth and development. Some economist believes that agriculture growth is a precondition to industrial development and economic growth, but ideas of other economist disagree and argue for a different path. Several researchers argued that economic growth depends on the development of the agricultural sector (Schultz, 1964; Gollin, Parente, and Rogerson, 2002).

Researchers believe that growth in the agricultural sector could be a catalyst for national growth through its effect on rural income and allocation of resources for transformation into an industrialized economy (Datt & Ravallion, 2002). A prior effort by several developing nations to industrialize their economy without previous agricultural development resulted in depressing economic growth rate and very much skewed income distribution (Bhagwati & Srinivasan, 1975). Timmer (1988) explain agriculture is the secondary sector that indirectly pays to the economic growth and development through its food price stability and availability of food and poverty reduction. In a hypothetical analysis, Matsuyama (1992) and Baig & Salam (2019) explained agricultural development is the foundation of economic growth for the developing nation. While many studies have outlined the theoretical relationship between agriculture and economic growth.

Researcher's findings contradict each other and have not reached on any consensus on this issue. Izuchukwu (2011) found the significant causal relationship among agriculture and economic growth and also argue that there is a significant positive impact of the agriculture sector on the economic growth in Nigeria. On the other side, the result of Dim & Ezenekwe (2013) shows the evidence against this result. While other many studies show the positive causality relationship among agriculture and economic growth by the use of different methodology (Oluwatoyese, 2013; Srikanth & Sathyanarayana, 2011). Recently, in the context of Bangladesh, one of the studies shows that one-way causality exists among agriculture and economic growth (Rahman & Hossain, 2014). While others found a negative relationship between the variables (Aggrey, 2009). Awokuse & Xie, (2015) explained the positive long-run impact of agriculture on economic growth. He considered the agriculture sector as a foundation for developing economies. The relationship between agriculture and economic growth is an empirical question for further investigation. Specifically, earlier research employed the correlation, and ordinary least square techniques may have problems due to spurious regression. However, findings explain only the association among the variables, but it failed to capture the directional causality between agriculture and economic growth. Tiffin & Irz (2006) applied a bivariate Granger's causality model to analyze causal relationship among the variables and result indicated the strong support in favor of causality running from agriculture to economic growth for the developing countries while the result is inconclusive in the case of a developed nation. Both of them have improved their study on the cross-sectional analysis, as they applied the modern time series in the modeling (i.e., co-integration and ECM) to examine the bi-directional causal relationships between agricultural value-added and economic growth. They show strong indication in support of causality running from agriculture to economic growth in the case of developing countries, but the causality results for developed nations were inconclusive. Another study by Storkey et al., (2013) investigated the causality relationship between agriculture and economic growth and saw a significant causal relationship among the variables. Matahir (2012) employed Johanssen co-integration techniques to examine the non-causality relationship between agriculture and other economic sector. He suggests that researchers should stress on the agriculture sector as a vital tool in the analysis of inter-sectoral growth policies. Recently Siaminamini (2017) investigated the impact of service and agriculture sector on the economic growth of sixty-two developing nations. She explains the service sector is directly associated with economic growth while inversely relationship between agriculture and economic growth. Thus, the multivariate causality framework employed to explore the causal relationship between agriculture and economic growth in India. The present study tries to fill the gap in the pragmatic works on the vibrant interaction between agriculture and economic growth. The primary objective of this study is to investigate short and long run causal relationship among agriculture, manufacturing and economic growth by the use of autoregressive distributed lag (ARDL) error correction mechanism and Granger's causality approach.

3. Data and Methodology

On the availability of annual times series data obtained from National Account Statistics (NAS) and Reserve Bank of India (RBI) from the period of 1966-2016 of the three variable, i.e., agriculture, manufacturing, and economic growth to explore the causality relationship for the short as well as long period of time among the variables.

3.1 Model

This study based on the three crucial variables namely agriculture growth (Gross Value Added), Manufacturing (Gross Value Added) and Economic growth (Gross Domestic Product) denoted by the X, Y, and Z respectively and also take the natural logarithm of each variable. In this model which is given below. Economic growth takes as a dependent variable whereas, agriculture and manufacturing growth are independent variables.

$$\ln(Z) = \alpha_0 + \alpha_1 \ln(X) + \alpha_2 \ln(Y) + U_t \dots \dots \dots (1)$$

3.2 Unit Root Test

Prior to run the regression, to check the stationarity to evade the spurious regression that misleads the result in the model. Augmented Dicky-fuller (ADF) and Phillips-perron (PP) test employ to detect the stationarity at all the levels (Dickey, & Fuller, 1961).

$$\Delta x_t = \theta_1 + \theta_2 t + \theta_3 x_{t-1} + u_t \dots \dots \dots (2)$$

The null hypothesis implies that unit root in the series and alternate hypothesis means time series as stationary. If the null hypothesis is rejected, times series is stationary. Primarily, we check time series are balanced or not. If balanced (all the variables are stationarity at the same level either integrated order 0 or 1), so at what level time series is stationary. If time series stationary at integrated at order 0. When the variables are trend stationary in the long-run relation, the common practice has been to de-trend the series and to model the de-trended series as stationary distributed lag or autoregressive distributed lag (ARDL) models (Peasaran & shin, 1999). However, we proceed towards the Auto Regressive Distributed Lag Bound Model (ARDL Bound).

3.3 ARDL Bound Test for Co-integration

This study employed recently developed the ARDL bound testing method to investigate short and long relationship among the agriculture, manufacturing and economic growth in India. We use the ARDL co-integration techniques (Peasaran & shin, 1999) and (Peasaran et al., 2001) which is basically overcome that problem that arises in the other co-integration models. There are several advantageous of ARDL Model comparing to other co-integration models such as Engel and Granger (Engel and Granger, 1987), Johansen and Johansen and Juselius methods. ARDL Model is applicable at any situation either variable is integrated order at '0' or '1' level and also at fractionally integrated. And other advantages in the long run model is that it gives the unbiased and efficient result if the sample size are small and finite (Harris & Sollis, 2003). And also Laurenson and Chai (2003) express the ARDL model overcome the non-sense regression coefficient problem. ARDL Model is insufficient for investigation the direction of the causality between the variables. To explore the direction of causality among the variables employed the Granger's causality test. The ARDL equation used in this given as follows.

$$\Delta \ln Z_t = C_{01} + \sum_{j=0}^p \alpha_{j1} \Delta \ln X_{t-1} + \sum_{j=0}^p \beta_{j1} \Delta \ln Y_{t-1} + \sum_{j=1}^p \gamma_{j1} \Delta \ln Z_{t-1} + \delta_{11} \ln X_{t-1} + \delta_{21} \ln Y_{t-1}$$

$$+\delta_{31} \ln Z_{t-1} + \varepsilon_{j1} \tag{3}$$

$$\Delta \ln Y_t = C_{02} + \sum_{j=0}^p \alpha_{j2} \Delta \ln X_{t-1} + \sum_{j=1}^p \beta_{j2} \Delta \ln Y_{t-1} + \sum_{j=0}^p \gamma_{j1} \Delta \ln Z_{t-1} + \delta_{12} \ln X_{t-1} + \delta_{22} \ln Y_{t-1} + \delta_{32} \ln Z_{t-1} + \varepsilon_{j2} \tag{4}$$

$$\Delta \ln X_t = C_{03} + \sum_{j=1}^p \alpha_{j3} \Delta \ln X_{t-1} + \sum_{j=0}^p \beta_{j3} \Delta \ln Y_{t-1} + \sum_{j=0}^p \gamma_{j3} \Delta \ln Z_{t-1} + \delta_{13} \ln X_{t-1} + \delta_{23} \ln Y_{t-1} + \delta_{33} \ln Z_{t-1} + \varepsilon_{j3} \tag{5}$$

In the above equation, ‘X’ denotes the agriculture growth, ‘Y’ denotes manufacturing growth and ‘Z’ represents economic growth. Where C_{0i} are constant terms, δ_{ij} are the long term coefficients, and ε_{ji} are the white noises error terms. The null hypothesis of no co-integration between the variables is $H_0: \delta_{11} = \delta_{21} = \delta_{31} = 0$ while its alternatives $H_1: \delta_{11} \neq \delta_{21} \neq \delta_{31} \neq 0$ in equation 3. In the equations (4) and (5) the null hypothesis is $H_0: \delta_{12} = \delta_{22} = \delta_{32} = 0$ and $H_0: \delta_{13} = \delta_{23} = \delta_{33} = 0$ against alternate hypothesis is that $H_1: \delta_{12} \neq \delta_{22} \neq \delta_{32} \neq 0$ and $H_1: \delta_{13} \neq \delta_{23} \neq \delta_{33} \neq 0$ respectively. The optimal lag length determined by the Akaike and Schwarz information criteria. Null hypotheses has been verified by computing the general F-statistics or Wald test and comparing them with two critical bound values (Lower and upper bound), that provide a band covering all possible classifications of the regressors into purely I(0), I(1) or mutually co-integrated. If the estimated value of F statistics is outside to the critical bound values, so the result are conclusive, and if F statistic lies inside critical bound values, in these conditions, the result is inconclusive. When F-statistics is greater than upper bound values, the null hypothesis will be rejected. While F-statistics is below than lower bound value, we can't reject the null hypothesis (Peasaran, 1997 & Peasaran et al., 2001).

3.4 Granger Causality Test

To investigate the direction of causality among the variables. Thus, we use causality test suggested by the Granger to analysis the causal relationship among agriculture, manufacturing and economic growth (Equation 6, 7 and 8).

$$\Delta \ln Z_t = C_{01} + \sum_{j=0}^p \alpha_{j1} \Delta \ln X_{t-1} + \sum_{j=0}^p \beta_{j1} \Delta \ln Y_{t-1} + \sum_{j=1}^p \gamma_{j1} \Delta \ln Z_{t-1} + u_{j1} \tag{6}$$

$$\Delta \ln Y_t = C_{02} + \sum_{j=0}^p \alpha_{j2} \Delta \ln X_{t-1} + \sum_{j=1}^p \beta_{j2} \Delta \ln Y_{t-1} + \sum_{j=0}^p \gamma_{j1} \Delta \ln Z_{t-1} + u_{j2} \tag{7}$$

$$\Delta \ln X_t = C_{03} + \sum_{j=1}^p \alpha_{j3} \Delta \ln X_{t-1} + \sum_{j=0}^p \beta_{j3} \Delta \ln Y_{t-1} + \sum_{j=0}^p \gamma_{j3} \Delta \ln Z_{t-1} + u_{j3} \tag{8}$$

In equation (6) the coefficients of variables of Agriculture growth and Manufacturing growth statistical different from zero. This shows uni-directional causality running from Agriculture and manufacturing growth to Economic growth. Similarly in the equation (7), if all the coefficients of agriculture and economic growth are statistically significantly different from zero. This implies that

one-way causality running from agriculture and economic growth to manufacturing growth. In equation (8), all the coefficients of manufacturing and economic growth are statistically significantly different from zero. This indicates the uni-direction causality is running from manufacturing and economic growth to agriculture growth. If none of them is statistically significant different form zero, in this condition no causal relationship between the variables. The adequacy and stability of the specified models were also analysis with various diagnostic tests for coefficients of determination (R-Square), Adjusted R-Square, J-Bera (Normality Test) test, Serial correlation (LM test), heteroscedasticity (White's test) and Structural stability (CUSUM tests and CUSUM Square).

4. Results and Discussion

Descriptive statistics shown the value of skewness of all variables are moderately greater than zero that indicated all the variables are slightly positive skewed. The economic growth are more skewed than agriculture and manufacturing growth. Moreover the probability of Jarque-Bera test are greater than 5 per cent we accept the null hypothesis i.e. "Data is normal" (Table,1).

Table: 1 Descriptive Statistics

Statistics	lnX	lnY	lnZ
Mean	3.9	3.58	4.41
Median	3.89	3.52	4.36
Maximum	4.22	4.3	5.08
Minimum	3.57	3.01	3.9
Standard Dev.	00.18	00.38	00.34
Skew.	00.08	00.28	00.32
Kurto.	1.81	1.89	1.87
J-B Test	3.05	3.29	3.58
Probability	0.21	0.19	0.16

Sources: Computed by the Author

Table 2, presented the results of unit root test (Augmented Dicky fuller and Phillips-perron Test) implies agriculture growth is the stationary at the 1 percent level of significance at the with or without trend levels while other two variables are also the stationary at the 1 percent level of significance at the without trend level. The marks of asterisk *, **, *** shows 1, 5, and 10 percent level of significance respectively.

Table: 2 Unit Root Test

Variables	A.D. Fuller Test			PP Test		
	T_n	T_c	T_{ct}	T_n	T_c	T_{ct}
Agriculture Growth (LnX)	5.53*	0.04	-5.74*	7.46*	-0.49	-5.93*
Manufacturing Growth(lnY)	11.83*	2.40	-1.11	15.82*	7.20*	-0.65
Economic Growth (lnZ)	14.46*	3.10**	-0.65	14.66*	4.13*	-0.38

Sources: Computed by the Author

After analyzing the stationarity, all the variables are stationary at the integrated order 0. We proceed towards the ARDL model. Prior to run the regression to find out optimal lag with the help of Akaike and schraz information criteria. Table 3, shows the agriculture and manufacturing growth which contribute the economic growth and development. Thus, comparatively agriculture growth is highly affected to economic growth in the short run (Table 3). The long-run coefficients of manufacturing growth showed the positive significant relationship between manufacturing and economic growth at the 10 per cent level of significance. Moreover the coefficient of agriculture growth shows positive impact on economic growth but it is insignificant.

Table: 3, Estimating ARDL (1, 1, 1) Model. Long and short run coefficients with ECT (-1). Economic Growth as a Dependent Variable

Variables	Coefficient	Std. Error	t-Ratio [Prob.]
Section (A): Long run coefficients [Estimated]			
Agriculture Growth (lnX)	0.028	0.028	1.00 [0.32]
Manufacturing Growth (lnY)	0.062	0.034	1.79 [0.07***]
Economic Growth (lnZ)	-0.072	0.052	-1.38 [0.17]
Section (B): Short Run Coefficient			
Agriculture Growth (Δ lnX)	0.34	0.03	9.64 [0.00*]
Manufacturing Sector (Δ lnY)	0.30	0.05	5.60 [0.00*]
ECT (-1)	-0.07	0.00	-8.00 [0.00*]

Sources: Computed by the Author

In the table 4, F-statistics i.e. 20.45 is greater than critical upper bound value which shows there is long-run relationship exist among variables at the 1 per cent level of significance. The value of Coefficient of error correction term is small and negative implies to adjust the disturbance in the long-run equilibrium in the slow process.

Table: 4 ARDL co-integration bound testing approach result

ARDL Model	Optimum Lag Length		F-Statistic
Variables X, Y and Z	(1,1,1)		20.45
Significance level	Critical Bound F-Values		
	Lower	Upper	
1 percent	3.88	5.3	
2.5 percent	3.22	4.5	
5 percent	2.72	3.83	
10 percent	2.17	3.19	

Sources: Computed by the Author

The specific ARDL Model (1, 1, 1), passes of all the diagnostic tests such as series auto-correlation, heteroscedasticity and normality (Table 5). We accept all the null hypotheses “There is no serial correlation and heteroscedasticity by the LM and white test respectively while in the Jarque-Bera test the null hypothesis are “Data is normal” as p-value are greater than 0.05 level of significance.

Table: 5 Result of Residual Test

Residual Test	F-Stat [Prob.]
Serial Correlation LM Test	0.7
Heteroschdasticity Test	0.8
Jarque-Bera Test	0.19

Sources: Computed by the Author

To check stability of specific ARDL model i.e. ARDL (1, 1, 1), we used cumulative sum of recursive residuals and cumulative sum square of recursive residuals suggested by the Brown in his research paper published in the 1975.

Figure: 1 Result of Stability of the Model [CUSUM-TEST]

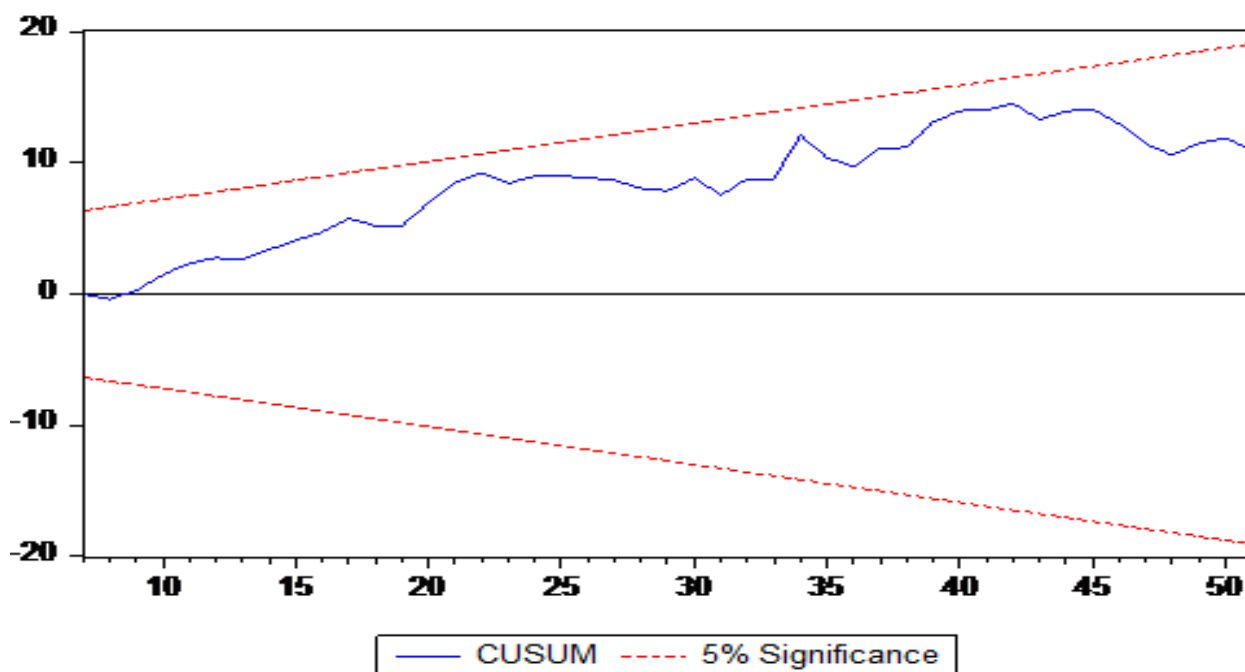


Figure: 2 Result of Stability of the Model (CUSUMQ-Test)

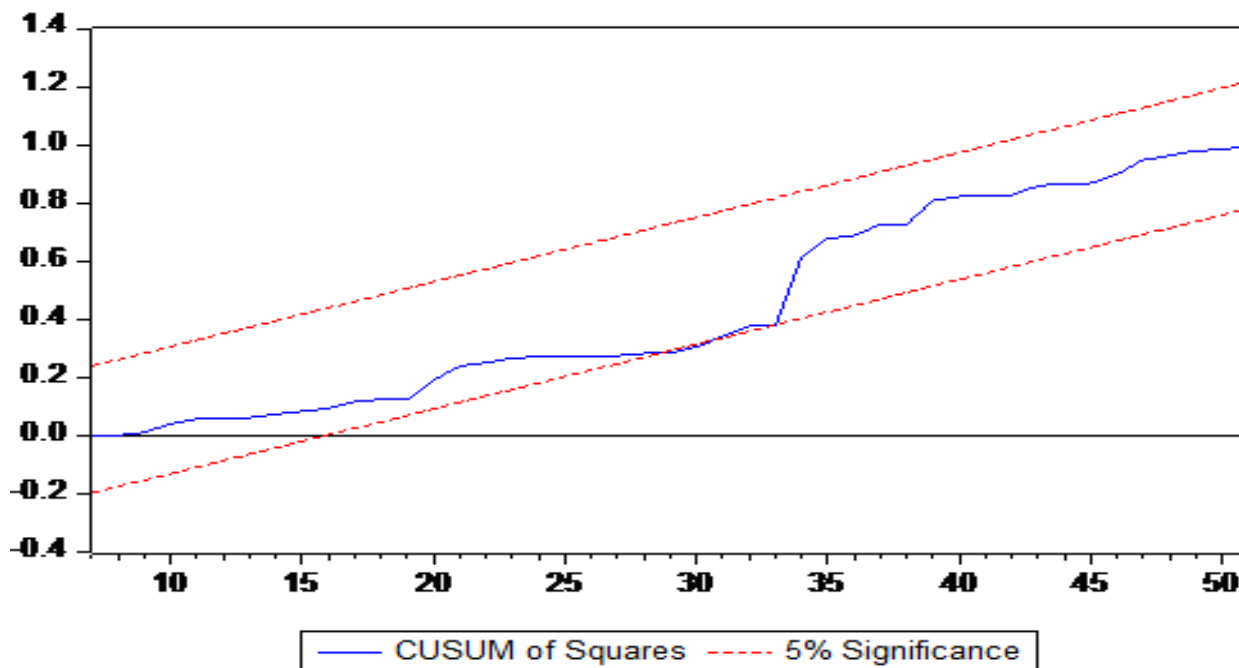


Fig. - 1 and fig.-2 are the plots of CUSUM and CUSUMSQ respectively remains within the 5 percent critical bounds and confirmed that model stable and policy prescriptions can be reliably derived from the coefficients of the model at the 5 percent level of critical bound values. The ARDL Model explores the only short and long-run relationship among the variables. To analysis, the causality among the variables, the Granger’s causality test had been used. Result of Granger’s causality shown in the table 6 indicated that one way causality running from manufacturing and economic growth to the agriculture growth. Moreover, uni-directional causality runnign from economic growth to manufacturing growth. However, result also explore the bi-directional causality relation between the agriculture and economic growth. Agriculture causes economic growth viz.a.viz economic growth causes agriculture growth. This result supported various previous studies such as Tiffin & Irz (2006), Sri kanth & Sathayanarayan (2011), Izuchukwu (2011), Oluwatoyese (2013), Storkey et.al (2013) and Rahman and Hossain (2014) in which explored the long run causality relationship and they found causality running from agriculture sector to economic growth. Apart from, some studies contradict this result namely Aggrey (2009) and Dim & Ezenekwe (2013) they found no positive significant impact of agriculture on economic growth. Result of this study showed agriculture sector is primary sector that directly contribute to the economic growth and development though providing of food to people of the country and raw materials to the non-agriculture sectors.

Table: 6 Causality Relationship (Granger causality Test)

Null Hypothesis	Observation	F-Statistics	p-value
lnX does not Granger cause lnZ	50	04.35	00.04
lnZ does not Granger cause lnX	50	17.3	00.002
lnY does not granger cause lnZ	50	0.12	00.72
lnZ does not granger cause lnY	50	8.4	0.005
lnX does not granger cause lnY	50	01.42	0.23
lnY does not granger cause lnX	50	23.7	0.0001

Sources: Computed by the Author

5. Conclusion and Policy Implication

To find out the answer of the most important question "Does the agricultural affects the economic growth?" in India from 1966 to 2016 achieved. Researcher employed the ARDL and Granger's causality Model to investigate causality relationship among i.e. Agriculture, manufacturing and economic growth for the short as well as long period of time. In the first step, we used the ARDL co-integration approach to investigate the short and long run relationship among the variables. In the second step, we applied the Granger's causality model to check the causality among the variables. Result indicated that one way causality running from manufacturing and economic growth to the agriculture growth. Nevertheless uni-directional causality running from economic growth to manufacturing growth. However, result also explored the two way directional causality between the economic and agriculture growth. Agriculture causes economic growth viz-a-viz economic growth causes agriculture growth. This study supported a very famous statement "agriculture is the engine of economic growth" this statement is valid for the short period of time but in the long run non-agriculture sector contributed more than agriculture sector to the economic growth in context of India. In India, agriculture is the primary sector of the Indian Economy since the 1950s. But from 1990s, non-agriculture sector leads to economic growth and development due to huge public investment. Policymakers ought to be emphasize on agriculture as well as the non-agriculture sector for formulating appropriate policy to improve overall economic condition and development in the country. However, empirical results of this study provide to the policymakers a better and clear empathetic of agriculture and economic growth nexus for framing appropriate policy for the short as well as long period of time that plays an important role to enhance and upgrade the standard of living of the people of India as a particular and for the low-income countries as a general. Government increase the percent of investment to GDP in the agriculture sector through the better irrigation facility, improved seeds technology and also open agricultural universities in each states to improve overall performance of the economy as well as standard of living of the farmers.

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