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An Analysis of Indian's Agriculture GDP Growth Rate

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Abstract: *Large segment of the Indian population is dependent on agriculture for livelihood, directly or indirectly. An attempt has been made by the author to empirically investigate India's agriculture GDP growth in India for the period 1971-2019, and forecasting the agriculture GDP growth for the period 2019-2026. Further, this paper checks if there is any structural break in the agriculture GDP caused due to economic reforms of 1991-92 by assigning dummy to the time, to understand the impact of economic reforms on the agriculture GDP through the regression analysis. It has been estimated that the growth rate in Agriculture GDP for the time period 1971-1991 was 2.6%, while the growth rate in agriculture GDP during 1991-2019 was 3.1%, and was merely 3% for the entire duration 1970-2019. This paper finds that indeed there was a structural break during 1991-92 which had a significant impact on agriculture GDP. Further, the forecasted data for Agriculture GDP for the time 2019-2026 gives result that agriculture GDP will be 3% on average. The forecasting has been done by making the series of agriculture GDP stationary using ARIMA (0,1,1) model, i.e. at 1st order differencing and MA process of order 1.*

Key Words: *Agriculture GDP, Growth, Stationary Data, Structural Break, Dummy, Forecasting*

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I. Introduction

The major essential for placing agriculture on the top of development agenda is that, a large segment of population depends on agriculture for their livelihood, there exists positive relations between poverty reduction and agriculture growth, and also, the sector is key to higher GDP growth rate through demand and supply routes. There are certain challenges to the agriculture sector as there is pressure to food system which is due to various factors, such as, ecological degradation, changing climate, rising energy, population growth, rising demand for meat and dairy products, etc. It may be possible that investment in agriculture will also get more attentiveness from the government after the recent farmers' protest against the farm laws. Recently a Government report "Committee on Doubling Farmers Income", in absolute terms, stated that, the additional private investment in agriculture sector that will be required to enable the doubling of farmers' real income in India by 2022-23 is Rs. 78,424 crore at 2015-16 prices (Rs. 46,298 crore at 2004-05 prices). While public investment usually strengthen infrastructure of the sector, private investment is associated with enhanced productive capacity.

A number of research studies have been conducted by economists on economic growth in agriculture. They have shared knowledge and results about the concept of economic-growth, its measurement determinants, effects and policy. The main objective of this paper is to assess the India's agriculture GDP growth in India for the period 1971-2019, and forecasting the agriculture GDP growth for the period 2019-2026.

II. Literature Review:

In this section a review of past research in the field has been compiled to enable better understanding of the problems concerned to the study.

Nagesh Kumar (2000), reviews Indian economy performance during 1990s and provides a sketch of economic reforms, and analysis their impact.

Daga and et. al.(2004), discusses that the government uses data on GDP at factor cost, and finds that GDP of India is a stationary process giving result contrary to the belief that economic reform causes a boost in the GDP.

Rahul Mukherji (2009), asserts that India's accelerated economic growth, at a rate greater than 5 percent in the period from 1975 to 1990, needs to be understood in the context of steady private sector orientation beginning in the mid 1970s, which accelerated in the 1980s.

Awokuse, O. T. (2009) in his paper titled "Does Agriculture Really Matters for Economic Growth in Developing Countries?" explores the dynamic interplay between economic growth and agriculture productivity and computes the association among these variables with time series analysis of fifteen transition and developing economies in Asia, Africa, and Latin America. The paper finds that agriculture is an important factor for economic growth, and as per their evidence public and private resource allocation to the agriculture development plays an important role.

Karl-Heinz Tödter, (2011), in their article, "The carry-over effect and its value in forecasting annual growth rates" measures the contribution of earlier years to growth in present year. They defined carry over effect to variables with frequency of less than an year, such as monthly or quarterly data, and examines that statistical overhang 'statistically', and quantifies its impact on forecast uncertainty.

Pinki Goel et. al. (2012), asserts that after India initiated reforms in 1991, economy liberalized the industrial sector from license-permit raj which has accelerated the growth of Indian economy.

PURNA CHANDRA PADHAN (2012), in their article on "Application of ARIMA Model for Forecasting Agricultural Productivity in India" applied multi-variate and uni-variate time series techniques for forecasting agriculture productivity in India using the data from 1950-2010, and forecasted the productivity for 5 years from 2011 onwards after validating the ARIMA model by selection criteria such as Minimum AIC, SIC value, Adj R^2.

Arjun. Y. Pangannavar (2015), attempts to assess the growth rate trends of Indian economy by using the measuring tool called 'Inclusive Growth', and concludes that endogenous model was in operation from 1956-57 till 1990-91 that placed economic growth rate at more than 5%.

Devanshi Dixit et al (2016), contend that after the adoption of LPG policy, India had gained an improvement in its share of world exports of goods and services as a consequence of globalization. Developed nations show their interest in Indian market and foreign investors started the investment in many sectors.

Urmi Pattanayak and Minati Mallick (2017) in their paper titled "Agricultural Production and Economic Growth in India: An Econometric Analysis", analyse the impact of agriculture production to economic growth in the country during the period 1991-2012, and finds that production of crops such as coffee, sugarcane, tea contributes significantly to the GDP growth, however, the sugarcane and coffee production has negative relation with economic growth.

Jamal, Aamir et. al. (2018), have considered a dummy variable which was incorporated as a proxy variable for economic reforms of 1991, and found the impact to be positive and significant which resulted that the economic reforms had made a positive impact on GDP growth of India.

Rudrani Bhattacharya, et. al. (2018), in their working paper titled "Forecasting India's Economic Growth: A Time Varying Parameter Regression Approach" forecasts GDP growth by using Principal Component augmented Time Varying Parameter Regression (TVPR) approach. They find that TVP Regression model surpass a Dynamic Factor Model in forecasting GDP growth at sectoral and aggregate level) in India.

Montek S. Ahluwalia (2020), states that some states have done exceptionally well, several others show a strong performance while some are doing very poor.

Paruchuru et. al. (2020), states that India is facing many challenges to hike economic growth which needs to be tackled effectively by government as it aims to attain $5 trillion economy by 2024-25.

Research Questions:

1. Growth rate estimation of agriculture GDP
2. Analysis the economics reforms impact on agriculture GDP, and compute growth rate pre and post economic reforms if there is structural break
3. Forecasting of Agriculture GDP at India level for next 7 years, and analyse growth rate

III. Data And Methodology:

The data of Agriculture GDP (at constant prices) for the time period 1971-2019 has been extracted from National Account Statistics from MOSPI. The data for 1971-2011 was available at 2004-05 prices, while the data for 2011-2019 was available at 2011-12 prices. Through splicing method, the entire data has been converted into base price of 2011-12 prices.

ANALYSIS 1: Growth rate estimation for the time period 1971-2019.

The equation of growth can be written as:

$$Y_t = Y_o(1+g)^t \quad \text{.....(i)}$$

Where Y_t is the GDP (at constant price) at time t, Y_0 is the GDP (at constant price) at time 0, g is the growth rate, and t is the time.

By taking log on both sides in equation (i), we get

$$LogY_t=LogY_o+t*log(1+g) \quad \text{...(ii)}$$

Now, we consider time component, t as the explanatory variable, and Log (GDP) is taken to be dependent variable. So, we have Log Y_o as the intercept coefficient and log(1+g) as the slope coefficient of the model.
The regression equation can be written as follows:
Log Y_i = $\beta_1 + \beta_2$* Time + u_i
The above equation is estimated using OLS regression command in Stata.

Dependent Variable - Log AGDP	
Independent Variables	
Time (Dummy variable)	0.0296**
Constant	12.97**
Adj R-squared	0.99
No. of observations	48

Note: Variables specified in log** denote statistical significance at 5% level, respectively.
Figures in parentheses are standard errors.
From the above results, for the time period 1970-2019, to calculate the growth rate, we can write in equation (ii),
Log Y_t = 12.97 + (0.0296)*t where 0.0296 = log (1+g), and Log Y_o = 12.97
To calculate g, we can take Anti log on both sides, we get
Growth rate, g = AL (0.0296) - 1 = 1.03– 1 = 3%
Thus, it can be interpreted that the growth rate of GDP in agriculture was merely 3% for the entire duration 1970-2019.
Now, we need to understand if there has been any significant impact of economic reforms on the GDP of agriculture.

ANALYSIS 2: Impact of economic reforms on the GDP of agriculture
To understand the impact of economic reforms on the agriculture GDP in the regression analysis, we have used dummy variable for the time and considered it as an explanatory variable. While the dependent variable in the analysis is log of Agriculture GDP.
Now, to check if there is any structural break in the agriculture GDP caused due to economic reforms of 1991-92, we assign dummy value of 1 after 1991-92 and value of 0 before 1991-92. Since the data of GDP is taken in log form,
The regression equation is as follows:
Log Y_i = $\beta_1 + \beta_2$* Time + u_i
Where, gross state domestic product (Y_i) in period t, is explained by time (which is given a dummy of 1 after 1991-92, and 0 before 1991-92 to analyse the structural change).

The following equation is estimated using OLS regression command in Stata.
Log Y_i = $\beta_1 + \beta_2$* Time + u_i

Dependent Variable - Log AGDP	
Independent Variables	
Time (Dummy variable)	-0.2996**
Constant	6.007**
Adj R-squared	0.408
No. of observations	48

Note: Variables specified in log** denote statistical significance at 5% level, respectively.
Figures in parentheses are standard errors.
The above analysis depict that economic reforms in 1991-92 indeed had a significant effect on the agricultural GDP, since the coefficient of dummy variable is significant at 5% level of significance. This reflects that there was a structural break in the data of agricultural GDP.
Growth rate estimation can be made from the analysis for the entire duration from 1971-2019.
The equation of growth can be written as:
$Y_t = Y_o(1+g)^t$ …..(i)
Where Y_t is the GDP (at constant price) at time t, Y_0 is the GDP (at constant price) at time 0, g is the growth rate, and t is the time.
By taking log on both sides in equation (i), we get
Log Y_t = Log Y_o + t*log(1+g) …..(ii)
Now, we consider time component, t as the explanatory variable, and Log (GDP) is taken to be dependent variable. So, we have Log Y_o as the intercept coefficient and log(1+g) as the slope coefficient of the model.

The regression equation is as follows:
$\text{Log } Y_i = \beta_1 + \beta_2 * \text{Time} + u_i$
The above equation is estimated using OLS regression command in Stata.

Dependent Variable - Log AGDP	
Independent Variables	
Time (Dummy variable)	0.0296**
Constant	12.97**
Adj R-squared	0.99
No. of observations	48

Note: Variables specified in log** denote statistical significance at 5% level, respectively.
Figures in parentheses are standard errors.
From the above results, for the time period 1971-2019, to calculate the growth rate, we can write in state
$\text{Log } Y_t = 12.97 + (0.0296)*t$ where $0.0296 = \log(1+g)$, and $\text{Log } Y_o = 12.97$
To calculate g, we can take Anti log on both sides, we get
Growth rate, g = AL (0.0296) -1 = 1.03– 1 = 3%
Now, since there was a structural break in 1991-92, as analysed above. The growth rate in Indian agriculture GDP can be separately computed for the period 1971-1991, and for the period 1991-2019.
Following is the procedure of estimation of growth rate
The equation of growth can be written as:
$Y_t = Y_o(1+g)^t$ …..(i)
Where Y_t is the GDP (at constant price) at time t, Y_0 is the GDP (at constant price) at time 0, g is the growth rate, and t is the time.
By taking log on both sides in equation (i), we get
$\text{Log } Y_t = \text{Log } Y_o + t*\log(1+g)$ …..(ii)
Now, we consider time component, t as the explanatory variable, and Log (GDP) is taken to be dependent variable. So, we have Log Y_o as the intercept coefficient and log(1+g) as the slope coefficient of the model.
The regression equation is as follows:
$\text{Log } Y_i = \beta_1 + \beta_2 * \text{Time} + u_i$
(i) Estimation of agriculture GDP growth rate during 1971-1991 period
The above equation is estimated using OLS regression command in Stata.

Dependent Variable - Log AGDP	
Independent Variables	
Time (Dummy variable)	0.0266**
Constant	13.00**
Adj R-squared	0.91
No. of observations	20

Note: Variables specified in log** denote statistical significance at 5% level, respectively.
Figures in parentheses are standard errors.
From the above results, for the time period 1991-2019, to calculate the growth rate, we can write in equation (ii),
$\text{Log } Y_t = 13.00 + (0.0266)*t$ where $0.0266 = \log(1+g)$, and $\text{Log } Y_o = 13.00$
To calculate g, we can take Anti log on both sides, we get
Growth rate, g = AL (0.0266) - 1 = 1.026 - 1 = 2.6%
= 1.026 – 1 = 2.6%
The agriculture GDP growth rate during 1971-1991 period was **2.6%.**
(ii) Estimation of growth rate during 1991-2019 period
The regression equation is estimated using OLS regression command in Stata.

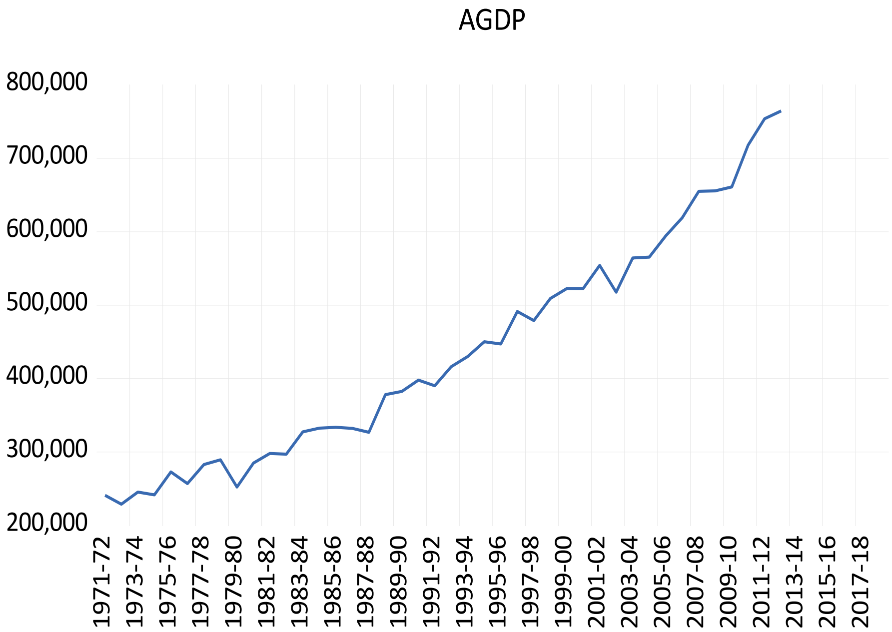
Dependent Variable - Log AGDP	
Independent Variables	
Time (Dummy variable)	0.0307**
Constant	13.55**
Adj R-squared	0.98
No. of observations	28

Note: Variables specified in log** denote statistical significance at 5% level, respectively.
Figures in parentheses are standard errors.
From the above results, for the time period 1991-2019, to calculate the growth rate, we can write in equation (ii),

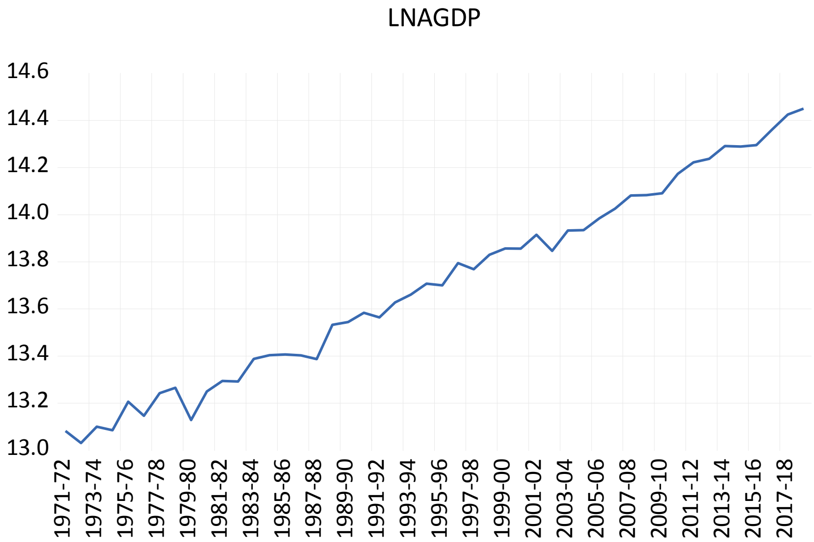
Log Y_t = 13.55 + (0.0307)*t where 0.0307= log (1+g), and Log Y_o = 13.55
To calculate g, we can take Anti log on both sides, we get
Growth rate, g = AL (0.0307) - 1 = 1.031 - 1 = 3.1%
The agriculture GDP growth rate during 1971-1991 period was **3.1%.**

Analysis 3: Forecasting of Agriculture GDP at India level for next 7 years, and analyse forecasted growth rate

Step 1: Following is the graph plot of agriculture GDP during 1971-2018 period

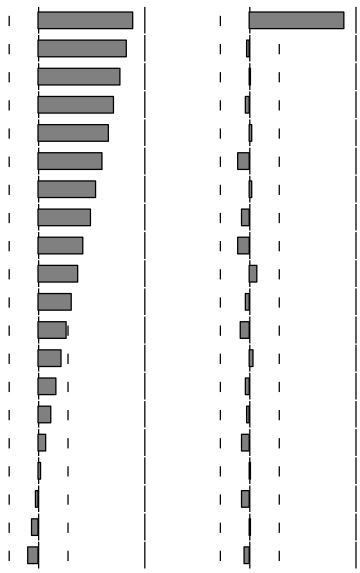


Step 2: Since the data of agriculture GDP is non stationary, we take log of agriculture GDP, shown by graph plot below.



Step 3: Now to check the stationarity, we first plot correlogram for log of agriculture GDP.

Date: 04/03/21 Time: 22:42
Sample: 1 48
Included observations: 48



	AC	PAC	Q-Stat	Prob
1	0.932	0.932	44.343	0.000
2	0.865	-0.024	83.400	0.000
3	0.804	0.005	117.86	0.000
4	0.742	-0.034	147.92	0.000
5	0.689	0.029	174.42	0.000
6	0.625	-0.116	196.72	0.000
7	0.569	0.032	215.67	0.000
8	0.510	-0.066	231.29	0.000
9	0.440	-0.121	243.18	0.000
10	0.385	0.067	252.57	0.000
11	0.331	-0.036	259.66	0.000
12	0.272	-0.083	264.58	0.000
13	0.223	0.036	267.98	0.000
14	0.172	-0.034	270.08	0.000
15	0.127	-0.029	271.25	0.000
16	0.075	-0.080	271.67	0.000
17	0.028	0.014	271.73	0.000
18	-0.017	-0.073	271.75	0.000
19	-0.060	0.000	272.05	0.000
20	-0.102	-0.054	272.95	0.000

We find significant spikes in PAC (upto 1 level), AC(upto 7-8 level) and then it exponentially decays. It means the data is non – stationary, and there is AR process upto 1 level, and MA process upto many lags. To establish non – stationary, we do unit root test.

Step 4: Now, while running the unit root test, we get following results:

Null Hypothesis: LNAGDP has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.433581	0.9823
Test critical values:	1% level	-3.581152	
	5% level	-2.926622	
	10% level	-2.601424	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNAGDP)
Method: Least Squares
Date: 04/03/21 Time: 22:43
Sample (adjusted): 3 48
Included observations: 46 after adjustments

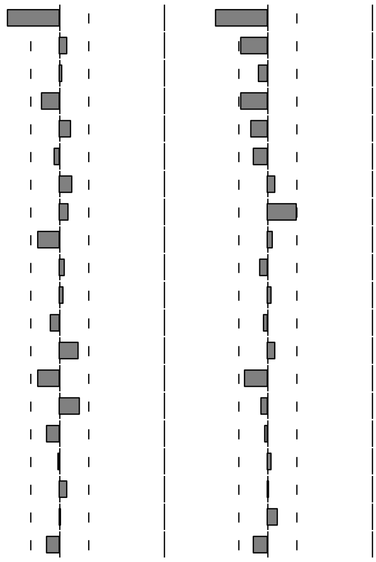
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNAGDP(-1)	0.007432	0.017141	0.433581	0.6668
D(LNAGDP(-1))	-0.520765	0.127785	-4.075313	0.0002
C	-0.055754	0.234371	-0.237890	0.8131

R-squared	0.279224	Mean dependent var	0.030865
Adjusted R-squared	0.245699	S.D. dependent var	0.052384
S.E. of regression	0.045495	Akaike info criterion	-3.279414
Sum squared resid	0.089003	Schwarz criterion	-3.160155
Log likelihood	78.42652	Hannan-Quinn criter.	-3.234739
F-statistic	8.328946	Durbin-Watson stat	2.296037
Prob(F-statistic)	0.000876		

It establishes clearly that the data is non stationary, since p value is (0.98), and we accept null of non-stationarity.

Step 5: Now, to make the data stationary, we check analysis at 1st differencing.
We plot correlogram of log of agriculture GDP at 1st differencing.

Date: 04/03/21 Time: 22:45
Sample (adjusted): 2 48
Included observations: 47 after adjustments



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.512	-0.512	13.112	0.000
		2	0.072	-0.257	13.381	0.001
		3	0.022	-0.091	13.407	0.004
		4	-0.174	-0.267	15.023	0.005
		5	0.120	-0.170	15.815	0.007
		6	-0.041	-0.133	15.911	0.014
		7	0.123	0.076	16.787	0.019
		8	0.086	0.295	17.220	0.028
		9	-0.221	0.055	20.174	0.017
		10	0.043	-0.079	20.290	0.027
		11	0.035	0.039	20.369	0.041
		12	-0.092	-0.041	20.923	0.052
		13	0.191	0.080	23.398	0.037
		14	-0.219	-0.223	26.760	0.021
		15	0.202	-0.059	29.682	0.013
		16	-0.126	-0.028	30.860	0.014
		17	-0.015	0.041	30.877	0.021
		18	0.070	-0.008	31.270	0.027
		19	0.004	0.098	31.271	0.038
		20	-0.124	-0.135	32.581	0.037

The spikes in both AC and PAC have significantly reduced after 1st level differencing of agriculture GDP, so it seems that data after 1st differencing has become stationary, but need to establish this using unit root test.

Step 6: Now, we analyse data at 1st differencing unit root test, to check if data has become stationary. Following is the result:

Null Hypothesis: D(LNAGDP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on AIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.03038	0.0000
Test critical values:	1% level	-4.170583	
	5% level	-3.510740	
	10% level	-3.185512	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNAGDP,2)
Method: Least Squares
Date: 04/03/21 Time: 22:46
Sample (adjusted): 3 48
Included observations: 46 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNAGDP(-1))	-1.519898	0.126338	-12.03038	0.0000
C	0.037799	0.014260	2.650667	0.0112
@TREND("1")	0.000337	0.000506	0.664965	0.5096

R-squared	0.771235	Mean dependent var	0.001669
Adjusted R-squared	0.760595	S.D. dependent var	0.092710
S.E. of regression	0.045362	Akaike info criterion	-3.285282
Sum squared resid	0.088482	Schwarz criterion	-3.166023
Log likelihood	78.56149	Hannan-Quinn criter.	-3.240607
F-statistic	72.48305	Durbin-Watson stat	2.295905
Prob(F-statistic)	0.000000		

We can conclude, that data of log (AGDP) (Agriculture GDP) has become stationary after 1st differencing.
Now, Looking at spikes in correlogram, we can state that probably AR(1), AR(2), AR(3) & MA(1) are present, we estimate equation to choose the ARMA model

Step 7: In ARMA (3,1) Model, we get

Dependent Variable: D(LNAGDP)
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 04/03/21 Time: 23:15
Sample: 2 48
Included observations: 47
Failure to improve objective (non-zero gradients) after 130 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.029667	0.001263	23.49627	0.0000
AR(1)	0.111093	0.223462	0.497145	0.6217
AR(2)	0.170070	0.269175	0.631821	0.5310
AR(3)	0.051519	0.204225	0.252266	0.8021
MA(1)	-0.999991	7407.964	-0.000135	0.9999
SIGMASQ	0.001568	0.771997	0.002030	0.9984

R-squared	0.433807	Mean dependent var	0.029113
Adjusted R-squared	0.364759	S.D. dependent var	0.053185
S.E. of regression	0.042390	Akaike info criterion	-3.297165
Sum squared resid	0.073673	Schwarz criterion	-3.060976
Log likelihood	83.48339	Hannan-Quinn criter.	-3.208286
F-statistic	6.282697	Durbin-Watson stat	1.868444
Prob(F-statistic)	0.000206		

Inverted AR Roots	.57	-.23-.20i	-.23+.20i
Inverted MA Roots	1.00		

Here, all explanatory variables AR(1), AR(2), AR(3), MA(1) are insignificant.
We now reduce the number of lag in AR, and reiterate the process.

Step 8: In ARMA (2,1) Model, we get the following result:

Dependent Variable: D(LNAGDP)
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 04/03/21 Time: 23:16
Sample: 2 48
Included observations: 47
Failure to improve objective (non-zero gradients) after 65 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.029662	0.001163	25.51562	0.0000
AR(1)	0.114142	0.225769	0.505571	0.6158
AR(2)	0.170386	0.263064	0.647698	0.5207
MA(1)	-0.999995	9399.299	-0.000106	0.9999
SIGMASQ	0.001567	0.679069	0.002308	0.9982

R-squared	0.433876	Mean dependent var	0.029113
Adjusted R-squared	0.379959	S.D. dependent var	0.053185
S.E. of regression	0.041880	Akaike info criterion	-3.337414
Sum squared resid	0.073664	Schwarz criterion	-3.140590
Log likelihood	83.42923	Hannan-Quinn criter.	-3.263348
F-statistic	8.047164	Durbin-Watson stat	1.885453
Prob(F-statistic)	0.000065		

Inverted AR Roots	.47	-.36
Inverted MA Roots	1.00	

All explanatory variables AR(1), AR(2), MA(1) are insignificant at 1%, 5% level of significance.
We now reduce the number of lag in AR, and reiterate the process.
Step 9: In ARMA (1,1) model, we get the following result:

Dependent Variable: D(LNAGDP)
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 04/03/21 Time: 23:18
Sample: 2 48
Included observations: 47
Convergence achieved after 33 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.029644	0.001955	15.16240	0.0000
AR(1)	-0.046989	0.276481	-0.169955	0.8658
MA(1)	-0.771149	0.198896	-3.877145	0.0004
SIGMASQ	0.001673	0.000319	5.238401	0.0000

R-squared	0.395669	Mean dependent var	0.029113
Adjusted R-squared	0.353507	S.D. dependent var	0.053185
S.E. of regression	0.042764	Akaike info criterion	-3.364214
Sum squared resid	0.078636	Schwarz criterion	-3.206755
Log likelihood	83.05903	Hannan-Quinn criter.	-3.304961
F-statistic	9.384364	Durbin-Watson stat	1.895292
Prob(F-statistic)	0.000069		

Inverted AR Roots	-.05
Inverted MA Roots	.77

Here, AR (1) is insignificant, while MA (1) is sign at 1%, 5% level of significance.
We now reduce the number of lag in AR, and reiterate the process.
Step 10: In ARMA (0,1) Model, we get

Dependent Variable: D(LNAGDP)
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 04/03/21 Time: 23:19
Sample: 2 48
Included observations: 47
Convergence achieved after 9 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.029637	0.001825	16.23518	0.0000
MA(1)	-0.799204	0.124718	-6.408062	0.0000
SIGMASQ	0.001673	0.000313	5.352137	0.0000

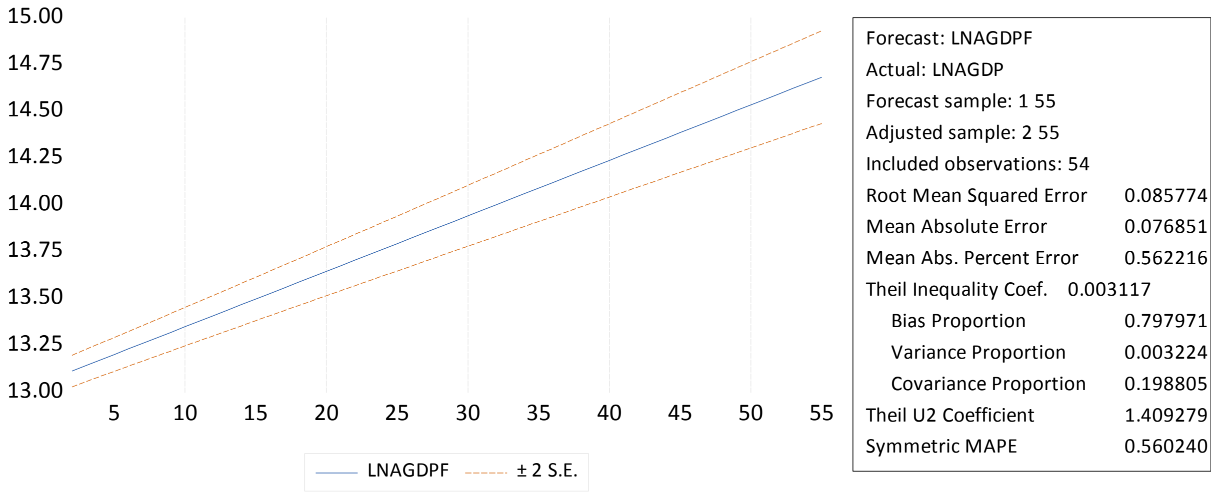
R-squared	0.395594	Mean dependent var	0.029113
Adjusted R-squared	0.368121	S.D. dependent var	0.053185
S.E. of regression	0.042278	Akaike info criterion	-3.405757
Sum squared resid	0.078645	Schwarz criterion	-3.287662
Log likelihood	83.03529	Hannan-Quinn criter.	-3.361317
F-statistic	14.39940	Durbin-Watson stat	1.938313
Prob(F-statistic)	0.000015		

Inverted MA Roots	.80

Here, MA (1) becomes significant at 1%, 5% level of significance.
Basis ARMA we can finally interpret that the data exhibit ARMA (0,1) model.
Now we use ARIMA (0,1,1) to forecast the series, after making the series stationary at 1st differencing.
Step 11: Outcome
And converting series back into original form of Agriculture GDP, we get the forecasted values for the next 7 years as follows:

YEAR	AGDP (Rs. In crores)
2019-20	19,92,339.23
2020-21	20,52,276.04
2021-22	21,13,994.83
2022-23	21,77,591.48
2023-24	22,43,101.36
2024-25	23,10,558.90
2025-26	23,80,068.91

Below, is the graph of forecasted series.



Now, the forecasted growth rate of Agriculture GDP for the time 2019-2025 is **3% on average.**

IV. Conclusion

From the above analysis, it can be concluded that the growth rate of the agriculture GDP was merely 3% for the entire duration 1970-2019 (time period considered in our analysis). Further while understanding the impact of economic reforms, and studying the structural reform if any, leads us to conclude that indeed there was a structural break during 1991-92 which had a significant impact on agriculture GDP. It has been estimated that the growth rate in Agriculture GDP for the time period 1971-1991 was 2.6%, while the growth rate in agriculture GDP during 1991-2019 was 3.1%. Further, the forecasted data for Agriculture GDP for the time 2019-2026 gives result that agriculture GDP will be 3% on average. The forecasting has been done by making the series of agriculture GDP stationary using ARIMA (0,1,1) model, i.e. at 1st order differencing and MA process of order 1. Given the pandemic situation, the overall economic growth in the country and hence, all the sectors are likely to get significantly affected negatively. Nevertheless, the government should strive to equally focus on improving the growth rate in agriculture GDP to boost the farmers income, and livelihood of majority section of the economy.

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Appendix

Following is the data of agriculture, forestry & fishing (GDP at factor cost at constant (2004-05) prices (`crore))

YEAR	AGDP
1971-72	4,80,345
1972-73	4,56,239
1973-74	4,89,097
1974-75	4,81,646
1975-76	5,43,729
1976-77	5,12,312
1977-78	5,63,729
1978-79	5,76,709
1979-80	5,03,036
1980-81	5,67,868
1981-82	5,94,000
1982-83	5,92,332
1983-84	6,52,281
1984-85	6,62,620
1985-86	6,64,703
1986-87	6,61,981
1987-88	6,51,470
1988-89	7,53,358
1989-90	7,62,316
1990-91	7,92,924
1991-92	7,77,442
1992-93	8,29,150
1993-94	8,56,700
1994-95	8,97,102
1995-96	8,90,864
1996-97	9,79,240
1997-98	9,54,233
1998-99	10,14,545
1999-00	10,41,625
2000-01	10,41,545
2001-02	11,04,112

2002-03	10,31,194
2003-04	11,24,502
2004-05	11,26,566
2005-06	11,84,466
2006-07	12,33,684
2007-08	13,05,192
2008-09	13,06,406
2009-10	13,16,961
2010-11	14,30,184
2011-12	15,01,947
2012-13	15,24,288
2013-14	16,09,198
2014-15	16,05,715
2015-16	16,16,146
2016-17	17,26,004
2017-18	18,40,023
2018-19	18,87,145

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