Impact of Macroeconomic Policies on Agricultural Performance in India: A Vector Auto Regression Approach

by Merlin Mathew

IMPACT OF MACROECONOMIC POLICIES ON AGRICULTURAL PERFORMANCE IN INDIA: A VECTOR AUTO REGRESSION APPROACH

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Abstract

Agriculture is a predominant sector for developing country like India even in the setting of its falling contribution towards countries overall domestic product. Its primary linkages to other sectors and the large dependence of the workforce in agriculture sector make it as a growth promoter as well as an employment multiplier. Since it has a potential impact on poverty reduction, the government has to take all the necessary initiatives to support this sector. In this context, the impact of various macro-level policies on agricultural performance needs to be analysed. The general belief is that macro policies have less impact on the agricultural sector and sector-specific policies are necessary to boost the primary sector like agriculture. The later may be true, macroeconomic policies may also have a non-trivial impact on the agricultural sector. In this study an attempt is made to analyse the extent of the impact that macroeconomic policies have on agricultural performance, using VAR approach. Causality, impulse response, and variance decomposition have been used for the impact analysis. The study revealed that there are several mechanisms by which the shocks to macro policies would be transmitted to decision variables in agriculture that finally affect the performance of the sector.

Keywords: Macroeconomic policy, Vector Auto Regression, Impulse response Function, Variance decomposition

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INTRODUCTION

Agriculture sector plays a decisive role in economic growth and development of India. Agriculture is the backbone of Indian economy- it contributes about 17-18 per cent to GDP. However, this grossly understates its importance because over 40 per cent of the population derive their livelihoods either directly or indirectly from agriculture and it accounts for at least -16 per cent of formal sector employment. Not only does it provide industrial raw materials; it is also an important source of intermediate and final demand for manufacturing sector. Apart from this the global significance of agriculture products are also increasing day by day.

Thus agriculture in developing nations is an important source of growth and employment multiplier and also it has strong forward and backward linkages with manufacturing and rest of the economy. Hence impact of macroeconomic policies have a greater bearing on the performance of agriculture sector.

Back to 1950’s the contribution of agriculture sector to Indian GDP growth was about 51.88 per cent. However, the contribution has gradually decreased for about 29.02 per cent in 1990 to 15.11 per cent in 2016-17 but it is employing about 47 per cent of the work force even now.

The general expectation is that overall macroeconomic policies have little impact on agriculture sector. Sector specific policies were always considered as a significant measure to boost the primary sector of our country. While the later may be true, the general macroeconomic policy environment may also have paramount effects on the agriculture sector.

Given the political, social and economic importance of food and agriculture, most governments are heavily involved in their nation’s agriculture sector and India is no different. The overall environment of Indian agriculture sector is significantly shaped by the government policies and action. Macro policies that largely influence the agriculture sector can be grouped into four viz., fiscal policies (Revenue and expenditure), Monetary policies (credit and interest rate) trade policies (foreign exchange and import/export control) and income policies (price and wage). The National Agricultural Policy Centre also established the links between the macroeconomic environment and agriculture: Through sector-specific measures, governments influence agriculture directly. These measures include tariffs, input and credit subsidies, price controls, quantitative restrictions, government expenditures and taxes.

A strong empirical evidence shows that agricultural sector in India benefitted reasonably from past government investments in agricultural research and development (Anonymous, 2012). The other study found out that total government expenditure on agriculture, nominal exchange rate and interest rate were all positively related with the index of agriculture production and government expenditure on agriculture was found to be the most important estimated macroeconomic variable required to cause growth and development in the agricultural sector, (Udensi *et al.*, 2012). Therefore, it is increasingly obvious that macroeconomic policies and instruments are prerequisites for the holistic growth and development of agriculture sector.

Therefore, this study aimed at establishing the relation between agricultural sector and some key macroeconomic fundamentals in the country since such interrelationships are decisive in accelerating growth and productivity in the agricultural sector of our country. The specific objective of the study is to estimate the extent and direction of impact of macroeconomic policies on agriculture performance.

DATA AND METHODOLOGY

Secondary source of data has been used for this study. To achieve the above said objective five broad macroeconomic indicators were selected for the analysis which directly captures the changes in macroeconomic policies in India. They were, Gross Fiscal Deficit of central government, current account balance, interest rate, inflation rate and exchange rate.

To capture the overall output performance of agriculture sector, three variables such as, investment in agriculture, agricultural export and agriculture GDP were selected. All the variables were taken to the model in standardized form. The annual data spanning from 1980 to 2018 collected from the Handbook of statistics on Indian Economy (2017-18) RBI was used for the analysis.

Vector Auto Regression Model

Vector Auto regression is a bi- directional multivariate forecasting algorithm that is used when two or more time series influence each other. Since the variables considered for the analysis were highly interdependent, Vector Auto Regression was employed for the analysis. In the VAR

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model, each variable is modelled as a linear combination of past values of itself and the past values of other variables in the system. Since the study use multiple time series that influence each other it was modelled as a system of equations with one equation per variable.

Let $Y_t = (y_{1t}, y_{2t}, ...y_{nt})$ denote an (n x 1) vector of time series variables. The basic p lag VAR (p) model (Sims 1980) has the form.

$$Y_t = C + \pi_1 Y_{t-1} + \pi_2 Y_{t-2} + \cdots \ldots\ldots\ldots. + \pi_p Y_{t-p} + \varepsilon_t$$

t = 1,….,T

π_1 are n x n coefficient matrix

ε_t is an n x 1 unobservable zero mean white noise process.

Different specifications of VARs used for the analysis were:

1. VAR based on (AGDP. GFDC, CAB, INFL (WPI), PLR, REER)
3. VAR based on (GCFA. GFDC, CAB, INFL (WPI), PLR, REER)
4. VAR based on (EXP. GFDC, CAB, INFL (WPI), PLR, REER)

Where,

AGDP= Agricultural Gross Domestic product (Rupees Crore)

GFDC= Gross fiscal Deficit of the Center (Rupees Crore)

CAB= Current Account Balance (Rupees Crore)

INFL (WPI)= inflation rate (Wholesale price index based)

PLR= Prime Lending Rate (%)

REER= Real effective Exchange Rate (%)

GCFA= Gross Capital Formation in Agriculture (Rupees Crore)

EXP= Agricultural Exports (Rupees Crore)

The general VAR (p) model has many parameters, and they may be difficult to interpret due to complex feedback between the variables in the model. As a result, the dynamic properties of a VAR (p) are often summarized using various types of structural analysis viz., Granger causality, impulse response function and forecast error variance decomposition

Granger causality

VAR model provides information about a variable's or group of variable's forecasting ability (Granger, 1969). If a variable y_1 is found to be helpful in predicting another variable y_2, then y_1 is said to Granger cause y_2. Otherwise, it is said to fail to granger cause y_2. Clearly it does not imply true causality but only implies forecasting ability. This causality is tested with the help of Wald statistics.

Impulse response function

The VAR framework permits to examine the 'impulse response functions' of one of the variables in the VAR to shocks in the other variables. In other words, we are able to assess the response of say agricultural investment to macroeconomic shocks in a VAR framework. However, for a VAR (p) with n variables there are n! possible recursive causal orderings i.e., the results of VAR analysis would be sensitive to the ordering of variables in the VAR. For example, if we have a VAR of three variables, viz., y1, y2 and y3 then the results may vary if we specify VAR as (y1, y2, y3) or (y2, y1, y3) or (y3, y2, y1). To overcome this ambiguity 'Generalized Impulse response Functions' have been used.

Forecast error variance decomposition

The forecast error variance decomposition explains what portion of the variance of forecast error in predicting y_i is due to structural shock. The 'variance decomposition' allow us to quantify the contribution of different variables in a VAR to the variability of a selected variable. For example, the contribution of macroeconomic variables to the variance of agricultural investment provides an assessment of the impact of the macroeconomic factors on agriculture.

Before proceeding with the analysis, the stationarity of the variables was analysed. For the VAR analysis it is necessary that only the stationary variables must be included. The results of ADF tests for unit roots are summarized in table 2 and accordingly the VARs were specified.

For the estimation of VAR, it is also necessary to specify the length of the lags of variables to be included in the analysis. the lag length for the VAR(p) model may be determined using model selection criteria. The general approach is to fit VAR(p) model with orders $p = 0,\ldots,p_{max}$ and choose the value of p which maximises the model selection criteria. The study employed AIC criteria for determining the lag-length for the VARs.

RESULTS AND DISCUSSION

1. Causality test:

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Existence of a statistical causal relationship between the macroeconomic variables and agricultural variables provides a basis for assessment of the nature of the impact of macroeconomic factors on agriculture. Granger block causality test was performed to analyse the existence of such a relationship between macroeconomic and agricultural performance variables. Five different macroeconomic variables have been chosen for the present analysis of the inter-relationship of agriculture and macro economy. Table 1 depicts the results of causality tests on three different agriculture performance variables and selected sets of the macroeconomic variables.

Table 1: Granger block causality test for the variables

Granger Causality from (Selected Macroeconomic variables)	To	Test statistics and p value
(CAB, GFDC, WPI, PLR, REER)	AGDP	12.19 (0.66)
(CAB, GFDC)	AGDP	35.23**(0.00)
(CAB, GFDC, WPI, PLR, REER)	GCF	32.62** (0.05)
(CAB, WPI, PLR, REER)	GCF	33.61***(0.00)
(CAB, GFDC, WPI, PLR, REER)	EXP	47.84***(0.00)
(CAB, GFDC,PLR, REER)	EXP	74.14***(0.00)

Note: Data used for the period 1980-71 to 2017-18; Test statistic is based on the log likelihood ratio test of the null hypothesis of no causality.

There was a strong evidence of causality from macroeconomic variables to agricultural sector according to the statistical test. The null hypothesis of absence of such a relationship was rejected at 1% and 5% level of significance. But the causality from macroeconomic variables to agricultural GDP appears significant when we consider only a subset of macro variables. In case of Gross Capital Formation all the macro variables were causing significantly. Same result was obtained for agricultural exports as well.

The overall conclusion that can be made from the above results is that there appears to be significant impact of macroeconomic variables on agriculture. Although not all the selected variables influence each of the chosen agricultural performance indicators, a subset of the macro variables does influence agriculture significantly. These results are in conformity with the findings of Bhide *et. al* (2005).

2. Augmented Dickey Fuller Test

Augmented Dickey Fuller test has employed to find the stationary series under the null hypothesis of presence of a unit root. Null hypothesis was rejected at first difference for the selected series (Table 2) .

Table 2: ADF test for stationarity

	Unit root test (with intercept and trend)			
Variable	ADF level t values	P value	ADF First difference t values	P value
AGDP	-0.093	0.995	-9.84	8.032e-013[1]***
GCFA	4.36	1	-5.15	0.001[1]***
AEXP	-2.993	0.134	-4.60	0.0009[2]***
CAB	-2.27	0.438	-5.36	0.0005[1]***
GFDC	-1.39	0.8441	-6.86	8.50e-006[1]***
REER	-2.64	0.265	-5.101	0.0001[1]***
PLR	-4.39	0.0069***	-6.98	5.931e-006[1]***
WPI	-4.88	0.0019***	-7.56	7.81e-007[1]***

1) The *** indicate rejection the null hypothesis at 1% significant levels.

2) The lag length of the ADF regression is specified in brackets [ ].

3. Lag length selection

Lag length of the VAR models were selected based on the Akaike criterion. For the VAR model, comprising of Agricultural Gross Domestic Product, and the five macroeconomic variables, lag length was two and the model with Gross Capital Formation in agriculture and five macroeconomic variables followed a log order of three. VAR model of Agricultural exports and the five macroeconomic variables used a lag length of two.

4. Impulse response function

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Impulse response analysis provides an estimate of the impact of a shock over time beginning with the year (period) in which the shock is administered. For the purposes of the present analysis, we have presented the results over an 18-year period from the year of the shock. This helps to examine the pattern of the impact and also quantify the impact over a period of time.

4.1 Impulse response of Macroeconomic variables on Agricultural investment (GCFA)

Table 3 represents the estimated impact of the one standard error shock of each macroeconomic factor on agricultural investment. Some general observation can be made from the impulse response pattern. It is clearly showed that impact of investment to shock in macro variables are more or less stable in the initial period, but it shows a fluctuation in the long run.

Table 3: Impulse response of Macroeconomic variables on GCFA

			Cumulative impact	
Variable	1st year	2nd year	10th year	18th year
GFDC	-0.0203	0.10809	0.725376	0.355776
CAB	0.01431	0.07496	0.125813	-2.94904
REER	0.19421	-0.0769	0.31957	-3.20437
PLR	0.00216	0.12201	0.453357	-2.75849
WPI	-0.0164	0.40656	0.019869	-10.7158

Even though higher fiscal deficit is a major macroeconomic problem facing in India, it has a positive long run effect on the agriculture sector of the country. Positive impact of a rise in GFDC in the long run suggests that agricultural sector will benefit from the effect of higher government expenditure. Some of the high expenditure may also support input use in agriculture.

The current account balance of assumes a significant dimension in the financial position of any country, and in fact, it is a pointer to the economic performance and the quality of management of such economy (Calderon et al, 2002). From the analysis it was revealed that, improvement in CAB has an adverse impact on agricultural investment. A lower CAD (or higher CAB) leading to an appreciating rupee may imply lower benefits from export and slowdown in agricultural investment driven by export demand for agricultural products in the long run. According to Adeyemo et al. , 2015, agricultural value added has a negative relationship with current accou t balance in which an increase in agricultural value added is consistent with a reduced CAB both in long run and short run. The explanation for this is integrally connected to the savings and investment identity that models the current account balance, such that when an economy invests more than it saves, it invariably leads to a current account deficit, (Yang 2011).

The initial positive impact on agricultural investment (GCFA) due to an increase in the PLR is counter intuitive. However, one expectation may be that, historically there would be lead lag relation between the interest rate chosen here (PLRX) and the interest rate relevant for the agricultural investment. This implies the possibility of a shift in investment from non-agriculture to agriculture sector. But in the long run the interest rate will further increase and investment in agriculture will decline.

Increase in inflation rate (WPI) has an adverse effect on agricultural investment. Although higher inflation resulting from crop failure may lead to higher crop prices and improved terms of trade. Crop failure also decreases farm ability to invest. The net impact is reduction in the investment.

4.2 **Impulse response of Macroeconomic variables on Agricultural Exports**

Impulse response shows that initial impact is positive for an increase in exchange rate and inflation rate. In the later period, there is larger negative impact although the impact is not uniform over the period. In case of GFDC and CAB shocks agricultural exports are stabilizing in the long run.

Table 4: Impulse response of Macroeconomic variables on Agricultural Exports (Rupees **crore)**

			Cumulative impact	
Variable	1 year	2 year	10th year	18th year
GFDC	0.00628	-0.0687	-0.07965	0.050903
CAB	-0.0679	0.05158	0.186866	0.139617
REER	0.00456	0.03051	0.001607	0.084686
PLR	0.03102	-0.1214	-0.11103	0.071494
WPI	2.18E-07	5.44E-05	-5.6E-05	-0.00014

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Impulse response is summarized in the Table 4. The fluctuating pattern suggests that the response to macroeconomic changes may be influenced by other factors as well. Improved CAB and reduced GCDC shows an improvement in agricultural exports in the long run. As similar to the other two agricultural variables export also exhibit a negative scenario against the inflation rate.

4.3 Impulse response of Macroeconomic variables on Agricultural Gross Domestic Product

It was evident that increase in fiscal deficit initially had negative impact on AGDP and in long term also it showed a negative impact which is lesser that the initial one. Earlier it was found that fiscal deficit positively impacts on investment. Thus, investment may give rise to higher output which in turn may reduce agricultural prices. Reduction in price may cause negative impact on agricultural GDP. Positive shock in CAB also shows a negative effect. In most of the cases the subsequent impact is lesser that the previous one.

Initial impact is negative for interest rate and inflation rate which indicate the reduced GDP. Higher rate of inflation is usually accompanied by poor agricultural output. Higher rate of inflation is usually accompanied by poor agricultural output. This in turn may adversely affect the income of the farmers for that year and hence their investment capabilities. The adverse effect on output in the next year would thus be a result of this phenomenon. This pattern is captured in the immediate adverse impact of higher inflation rate on agricultural GDP. The adverse impact of higher interest rate on agricultural GDP may also reflect the same pattern of impact as higher inflation and higher interest rates coincide with poor agricultural output.

Table 5: Impulse response of Macroeconomic variables on AGDP (Rupees Crore)

			Cumulative impact	
Variable	1st year	2nd year	10th year	18th year
GFDC	-0.1639	0.16957	-0.05062	-0.06922
CAB	-0.124	-0.0473	-0.09021	-0.0213
REER	0.21613	0.26502	0.255843	0.263498

PLR	-0.2337	0.1795	-0.12004	-0.10997
WPI	-0.4784	0.4439	-0.27586	-0.23752

Along with some expected linkages, the results also presented some counter-intuitive implications of changes in the macroeconomic conditions. However, some of the expected linkages are also present, rising fiscal deficit at the Centre appears to have an adverse impact on agriculture GDP. Improvement in CAB had a positive impact on export. Higher interest rate had a negative impact on GDP and investment. An appreciating rupee has a positive impact on GDP. Increasing inflation rate resulted in reduction of all the agricultural variables. Thus, the results presented above shows that the macroeconomic factors do influence agriculture through a number of interfaces (Table 6). Thus, the agricultural sector is not immune to macroeconomic policy changes.

Table 6: Impact of macroeconomic factors on agriculture (cumulative impact response over 18 years)

Variables	Agril. GDP	Agril. investment (GCFA)	Agirl. exports (EXP)
GFDC	Negative	Positive	Positive
CAB	Negative	Negative	Positive
REER	Positive	Negative	Positive
PLR	Negative	Negative	Positive
WPI	Negative	Positive	Negative

5. Variance decomposition

VAR methodology presents a means of assessing the contribution of different variables in a system to changes in any given variable within the VAR. The 'variance decomposition'

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component provides an estimate of the contribution of a variable to the variability of another variable in the VAR. We apply this variance decomposition technique to assess the contribution of the macroeconomic variables to variability in the selected agricultural variables. Table 7 to 9 summarizes the results of the variance decomposition analysis. The results indicates that the macroeconomic factors are important in explaining the variability in agricultural performance indicators over the years.

Table 7: Variance decomposition for Gross Capital Formation in Agriculture

years	GCFA	GFDC	CAB	PLR	WPI
1	100	0	0	0	0
2	67.38	12.49	14.20	0.85	5.05
3	66.58	10.27	16.14	1.24	5.75
4	58.82	10.42	21.62	1.48	7.64
5	58.37	8.79	23.61	1.44	7.76
6	57.47	8.00	25.59	1.39	7.52
7	57.55	7.50	26.61	1.37	6.94
8	57.27	7.44	27.38	1.41	6.48
9	56.95	7.54	27.83	1.47	6.18
10	56.58	7.70	28.11	1.53	6.06

Table 7 shows a declining contribution of GFDC over the years. But for the other variables it is increasing or steady over the years. Current account balance alone explains nearly 30 per cent variation in Gross Capital formation due to the impulse in the long run. But interest rate is showing a steady influence in the fluctuations in both short run as well as short run.

Table 8: Variance decomposition for Agricultural exports

Years	EXP	GFDC	CAB	REER	WPI
1	100	0	0	0	0
2	52.43	30.68	15.13	0.21	1.53
3	40.43	38.54	17.11	0.17	3.72
4	35.32	40.25	17.58	0.76	6.06
5	32.99	39.42	17.31	2.48	7.77
6	31.71	38.04	16.75	4.94	8.54

7	30.92	36.96	16.25	7.20	8.64
8	30.45	36.35	16.00	8.64	8.54
9	30.23	36.09	15.93	9.24	8.48
10	30.15	36.03	15.94	9.37	8.49

In Table 8 GFDC and CAB together explain more than 50 per cent variation in the agricultural export in short run as well as in long run. REER and inflation rate also explain significantly the variations in agricultural exports due to a standard error shock.

Table 9: Variance decomposition for Agricultural Gross Domestic Product

	AGDP	GFDC	CAB	REER	PLR	WPI
1	100	0	0	0	0	0
2	89.01	6.51	3.79	0.02	0.67	0.01
3	80.02	11.77	6.07	0.05	1.62	0.45
4	74.96	14.00	6.84	0.05	1.86	2.27
5	72.39	13.80	7.14	0.12	1.73	4.80
6	71.05	12.83	7.51	0.56	1.60	6.43
7	70.03	12.41	8.04	1.22	1.52	6.75
8	68.94	12.71	8.58	1.66	1.52	6.55
9	67.96	13.22	8.92	1.79	1.57	6.51
10	67.34	13.55	9.04	1.78	1.61	6.65

Table 9 clearly indicates the contribution of each variable in explaining the variation in AGDP. Over the years contribution is increasing for each variable. In the short run agricultural GDP itself explain more than 70 per cent variation due to an own shock. But the contribution of other variables together was negligible in the short run. In the long run contribution of another variable has increased to more than 20 per cent.

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CONCLUSION

Study clearly revealed that there are several mechanisms by which the shocks to macroeconomic variables would be transmitted to decision variables in agriculture and finally affect the performance of the sector. The group causality showed that agriculture sector is influenced by the macroeconomic condition. Results of impulse response analysis capture the direction of the impact of macroeconomic shocks to agriculture. The direction of the impact is not always along the 'expected lines' indicated by structural relationships, suggesting significant inter-relationships of variables. Variance decomposition analysis suggests that macroeconomic factors may contribute 40-50 per cent of the variance of the various agriculture related variables. Its contribution is increasing over the years. The present analysis has pointed to the substantial impact of macroeconomic factors on agriculture. The analysis does not fully track all the transmission mechanisms but is suggestive of the likely links. While the results need to be qualified by the underlying assumptions, it is difficult to ignore the need to keep in view the changes in the macroeconomic factors to understand the changes in the agricultural sector.

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